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## The Utilization and Disposal of Municipal Waste.


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Modern sanitation has for its purpose the preservation and prolongation of life by the enforcement of certain fundamental principles, or rules of action. These principles are, generally speaking, preventive in character; they aim to minister to the well-being and happiness of mankind by removing or modifying the causes of disease and discomfort.

Various methods of sanitary work which were formerly almost unknown have in the past quarter of a century made great advancement. Regulations against the pollution of the water supply; restrictions and oversight of the sale of foodstuffs; isolation and quarantine of infectious diseases; the use of antitoxin remedies; disinfection by steam and formaldehyde gases; the latest demonstrations of the con-

veyance of certain forms of fever by insects. These and many allied forms of research and discovery, practical or theoretical, are evidence of the enormous strides made in sanitary science in the past twenty-five years.

There is another practical and exceedingly interesting aspect of this work which affects the daily life of the great public both financially and physically, and which it is our purpose to briefly describe.

Every citizen, however large or small the community may be, is directly interested in the conditions that affect his health and comfort, and his pocketbook. When a street is badly paved, or unwatered or unswept, every passing person is aware of it and has a right to demand a remedy because he is personally concerned.

If we consider for a moment the enormous bulk of material brought into a city by the various agencies which are necessary for the daily support of life, and remember that after change and assimilation there remains a mass of effete and worthless matter, equal in amount to nearly 75 per cent. of the original quantity, we can begin to comprehend the difficulties of the problem of removing from the life of the people this great volume of waste. It is a problem that must be solved in a speedy and satisfactory manner, and one of great importance to the health of the city.

The waste of a community may be divided into two separate parts:

*Organic.*—All substances which are subject to decay and putrefaction, and in this condition objectionable and dangerous to health. This includes all forms of foods, and the bodies of animals, and may comprise sewage and the contents of vaults and cess-pools.

*Inorganic.*—Substances that are not subject to rapid decay and putrescence, but which may be exhausted by use and rendered worthless, such as ashes, street sweepings, refuse, rubbish and discarded household utensils and furnishings, and the waste from stores and factories. For convenience, these are included in the general term ashes, street sweepings and refuse, or rubbish.

Excluding sewage, which is conveyed away by under-

ground conduits, or which is taken from vaults by excavation and separately dealt with, and the carcasses of larger animals which are also separately collected and treated, we have remaining garbage, ashes, refuse and street sweepings, and it is our purpose to consider the disposition of these.

*Divisions of City Waste.*—Municipal waste, comprising garbage, street sweepings, ashes and refuse, or rubbish, is divided into the following approximate proportions:

| | By weight. Per cent. | By volume. Per cent. |
|---|---|---|
| Ashes | 65 | 47 |
| Street sweepings | 17 | 12 |
| Garbage | 10 | 10 |
| Refuse | 8 | 30 |

These figures, from the reports of the city of New York, apply in a general way to the larger cities where the same fuel is used. The whole proportion of municipal waste of New York City is about 4 pounds per capita per day. This is far larger than it is in the other large cities of the world; that of London is about 1·6–10 pounds, of Berlin ·9–10 pounds, of Hamburg 1·1–10 pounds; in Philadelphia this proportion is 3·5 pounds per capita per day. But the local conditions in each city differ, therefore each city should be considered by itself, and the results obtained will be found to be governed by the circumstances peculiar to each.

*Ashes.*—The analyses of city ash show that about two-thirds are from households, and one-third from large furnaces, steam boilers, etc., where the coal used is of the smaller sizes and is more thoroughly consumed.

| HOUSE ASHES. | Per cent. | STEAM ASHES. | Per cent. |
|---|---|---|---|
| Coal | 25 | Coal | 15 |
| Fine ash | 50 | Clinker | 40 |
| Clinker, slate | 15 | Fine ash | 45 |
| Rubbish | 10 | | |

When the fine ash is taken from steam ashes the residuum is of value for use as the basis of concrete for foundations, floors and fillings.

The disposal of these ashes upon dumps is an almost universal custom. Low ground is filled with mixed ashes and refuse, the admixture of matters liable to decay renders the

whole mass unsanitary and unstable; floating clouds of dust rise with every wind, the whole neighborhood is littered with flying paper; the odors and exhalations become a public nuisance, and the presence of putrescible matter and flies in summer threaten the health of adjoining property owners.

*Street Sweepings.*—Leaving out of consideration the removal of snow, which for present purposes will not be reckoned as part of the city waste, the sweepings from the streets claim attention. In a general way, the proportionate quantity for an average northern city with asphalt, block and brick pavings will be from 15 per cent. to 20 per cent. of the whole waste collection. This, of course, varies with the area of paving, the methods of sweeping and with the character of the population.

The component parts of street sweepings are approximately as follows:

| | Per cent. |
|---|---|
| Moisture | 35 |
| Organic matter | 30 |
| Ash, sand, rubbish, etc. | 33 |
| Nitrogen, phosphoric acid, potash | 02 |

There is undoubtedly value in street sweepings for land fertilization, as the percentage of organic matter and nitrogenous compounds is readily taken up by the soil, but the presence of nearly 50 per cent. of inert waste makes the cost of collection, transportation and application so large as to practically offset its value as manure. Experiments made on a large scale in several cities show that the street sweepings if delivered by short transportation direct to farms will be accepted and used, but no revenue to the city will result.

Sweepings can be destroyed by incineration, if furnaces of large capacity with forced draft are used, no fuel being needed. Taken in conjunction with other wastes sweepings may readily be burned, and will yield an equivalent in steam power. If dumped upon open lots and exposed to rain, there is inevitable putrefaction and consequent noxious odors.

Attention should be given to the fact that sweepings contain colonies of germs, or bacilli, that are dangerous to human life. In the experiments made under the direction

of the Commissioner of Street Cleaning of New York City, by the exposure of agar plates at the street level and 6 feet above, at various points in the city, and by noting the number of colonies of bacilli developed within a given time, there was found to be a maximum of thirty colonies per square inch gathered in the crowded streets of the east side tenement districts, the purpose of these experiments being to show the effects of traffic in distributing the bacteria in different air layers. A statement made by a leading specialist in the treatment of diseases of the head was to the effect, that after a dry season, followed by a brisk wind in New York streets, the increase of catarrhal and asthmatic diseases was very marked, and attributable to foreign organisms floating in the air.

*Garbage.*—The third division of municipal waste, comprising all the rejected and condemned food products from dwellings, shops and markets, the bodies of dead animals, and generally all that matter which by decay and putrefaction becomes objectionable, is known as garbage, and is approximately 12 per cent. in weight of the total waste collection.

The component parts of the average city garbage are as follows:

| | Per cent. |
|---|---|
| Moisture | 65 |
| Solids | 25 |
| Foreign substances | 06 |
| Grease | 04 |

Three or four methods for the disposition of this waste are in use: feeding to swine; dumping on low ground or into large bodies of water; plowing into ground; reducing, to extract the grease; and cremating.

Many New England cities practice the first method, maintaining through municipal ownership, or by contract, large farms where herds of swine are daily fed with the city garbage.

There are cases where a small amount of swill collected by private parties from hotels and fed when fresh can be safely and economically used; but when garbage remains in mass twenty-four hours in hot weather, fermentation sets

in, the liquids turn sour, and it becomes unfit for swine food. There are several cases on record where an epidemic of hog cholera has carried off the whole herd. The report of the State Board of Health of Massachusetts some years ago showed that trichinosis was developed in 17 per cent. of cases that were traced directly to the eating of hogs fed on the city garbage.

*Dumping.*—The deposit of large masses of garbage on ground in the vicinity of towns is universally condemned as unsanitary and positively dangerous. Numerous instances could be quoted of the inception and propagation of zymotic diseases from this source, instances that are too well supported to be questioned.

The statement of a former health officer of Philadelphia, made to the writer some years ago, was to the effect that many cases of diphtheria were traceable to the presence of exhalations from ground where large amounts of city waste had been dumped in former years.

When garbage is dumped into water, unless the conditions are specially favorable as to the prevailing winds and currents for the avoidance of the deposit of the material on neighboring shores, and the dumping is done far enough out to sea to prevent the choking of navigable channels, this method cannot be employed with success. With the exception of New Orleans and some western cities on the Mississippi, the custom has been abandoned.

*Plowing into the Ground.*—When fresh garbage is spread upon the surface of the ground, if free from metals and other foreign matters, it can be plowed under. On sandy soils this method has been attended by good results; but, as large areas of ground are infrequent in city neighborhoods, this is not an easy method to put into use. Moreover, this method of disposal cannot be employed in consecutive years. The ground does not oxidize and assimilate the charge fast enough to permit another charge for two or three years.

*Reduction Process.*—By this method the garbage is treated by a process of cooking, or steaming, separating it into fats or grease, water, and tankage, or residuum.

The special machinery used includes digestors, or cook-

ing tanks, presses, dryers, fume-destroyers, and condensors and mills for grinding the residuum. Being a trade process protected by patents and in the hands of close corporations, a knowledge of the exact methods, apparatus and results is not to be had. But the description of a plant erected in a neighboring city under the Arnold system gives a clear idea of the means employed. The specifications provide that "The system of final disposal shall be thorough sterilization of all material by means of live steam at a temperature not less than 282° F., the material to be subjected to this temperature in a closed vessel absolutely steam tight, at a working pressure of not less than 60 pounds per square inch for not less than eight hours. From the time the material is delivered into the said vessel it shall not be exposed to the open air until after it has been pressed so that the solid part of the material shall contain moisture not exceeding 55 per cent., after which it may be finally disposed of by cremation, acidulation, or reduction for use as a fertilizing material.

"Four of the digestors constitute what is known as a battery, and each battery is connected with a pressing machine used for separating the liquids from the solids. From the presses the liquids flow through a trough into the grease-room, where, after cooling, the grease is skimmed off for use in soap and lubricating oil manufacture, while the rest of the liquid is evaporated under vacuum. After this evaporation it is known as 'stick,' and is mixed with the dried tankage (the solid matter) to form a fertilizing base. The tankage is carried from the pressroom to another part of the plant, where it receives a further treatment with phosphate, and is converted into a good brand of fertilizer."

The beginning in reduction methods in this country was in Buffalo in 1887 by the introduction of the "Merz" process, of Vienna. This method was afterwards used in six other large American cities, but abandoned in all except one (St. Louis) for various reasons.

The Arnold process, which came into use in New York, Philadelphia, Boston and Brooklyn, is still employed in these cities.

The Chamberlain system is used in Detroit, Washington and Cincinnati; the Weisloge̊l system, a modification of the Merz process, at Indianapolis; and the Holthaus system, after being tried at Bridgeport, New Bedford and Syracuse, is now in use in the latter city only.

At this date twenty-four cities are employing the reduction process, under five different methods, each differing slightly in the manner of treating the garbage.

In the last four years reduction plants dealing with garbage only, have been established in the cities of Washington, Baltimore, Newark and Cincinnati. These cities awarded contracts for a term of five years to the reduction companies upon the ground that these companies possessed the requisite capital to construct large, expensive disposal plants, and to carry them on with the expectation that the revenue to be derived from this work, together with the payment of a bonus by the city, would warrant them in undertaking a contract of great magnitude.

In order to get possession of these contracts the reduction companies were forced to compete with the local contractors in making the collection of garbage, and they were therefore obliged to put into this collection-contract a large sum of money for the purchase of a plant and the maintenance of a force of men and teams which would take the garbage from the houses of the people and bring it to the works.

Because of the unsanitary conditions and the nuisance connected with the disposal of garbage by reduction, the works are forced into locations considerably removed from the city proper, entailing thereby great expense in the transportation of the garbage, which expense is borne by the city.

In one case, where the reduction works were situated about a mile from a residential part of the city, the offensive odors and fumes became so annoying and so menacing to health, that the city was compelled to order the removal of the works, and was obliged to pay $140,000 to have it done, because the reduction company adroitly claimed and proved that it was there by direction of the city and was therefore not responsible.

Another reduction company having a plant in operation were the highest bidders for a contract. They were underbid $110,000 a year by a rival corporation, and when the contract was awarded to the lowest bidder it was found that as a limited time was stipulated for the construction of the works—less than one month in which to erect the apparatus and buildings that would have taken more than six months to build—the contract was necessarily abandoned by the lowest bidder, and was thereupon handed over, at their own figures, to the reduction company which had possession of plants ready to operate.

In another city the contract was let for five years, and practically no bidders were allowed to compete who did not have works of the largest capacity ready for immediate operation. It is hardly necessary to say that the contract went to the only bidder at an advance of nearly four times the previous price.

The foregoing shows that a reduction company with works already operating can simply hold a city at its mercy, can defy competition by adroitly shortening the time which would be necessary for the construction of an opposing plant, thus obtaining their own price with little, if any, chance given for successful competition.

So it has come about that in their garbage disposal work the largest cities of the country are in the hands of a monopoly composed of a number of corporations bound together by a common purpose, dividing the territory and mutually supporting, not opposing, each other, and putting it out of the power of any other company to compete successfully.

It has been stated by parties who are very well posted on the products of reduction, that the grease and tankage recovered by the treatment of garbage are of value more than sufficient to pay all the expenses of the work and leave a very good margin of profit, even if the city did not contribute one cent to the support of the company. It is known that 3 to 4 per cent. of grease can be recovered from the average ton of garbage, and that there is a certain amount of residuum, about 20 to 30 per cent., coming from vege-

table matter or the tankage left after the drying and steaming processes, which has some value as a filler for fertilizer. To these may now be added a third element of profit in the shape of a residuum to be derived from the evaporation or distillation of the water discharged from the garbage in the process of cooking by reduction. The constituent obtained (ammonia) is the most valuable of all the items that enter into the manufacture of fertilizer, and it is understood that this can be saved by the process now in use in the most modern reduction plants. It may be accepted as a fact that the total value of the manufactured articles derived from the reduction of garbage represents not less than $2.50 for every ton of 2,000 pounds of average city waste treated in this manner. The expenses attending the recovery are large, but the balance of profit is sufficient to afford a very good return for the money invested.

Within the last two months an incident has occurred in the matter of disposal of garbage by reduction which, if it proves successful, will cause a revolution in the future of this work. A Western city advertised for bids for the disposal of the garbage, dead animals and nightsoil of the city, the work to be done by approved methods within city limits, or within an area of three miles, the city to collect and deliver all the waste. A proposal was received and accepted from a responsible company, backed by the required bond, to take all three forms of waste, free of expense to the city, and treat them after the company's own methods, without nuisance. This company will derive its revenue solely from the manufactured products of the waste.

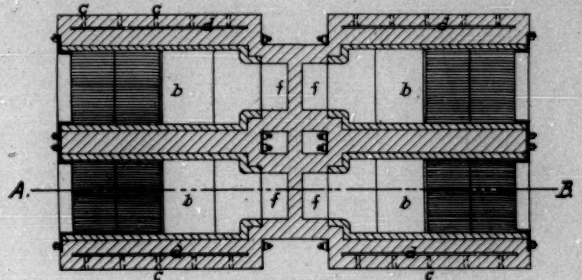
If this process be practical—and a year will demonstrate this—then there may be a new factor to be reckoned with in the disposal of garbage by the reduction process.

### DESTRUCTION BY FIRE.

There are two remaining methods for the treatment of municipal waste to be considered: first, cremation in closed furnaces, and the utilization for steam power of the heat thus produced; and second, the utilization of such parts of the refuse as may be sold for conversion of manufacture into

other forms of usefulness, and the disposal of the worthless residuum.

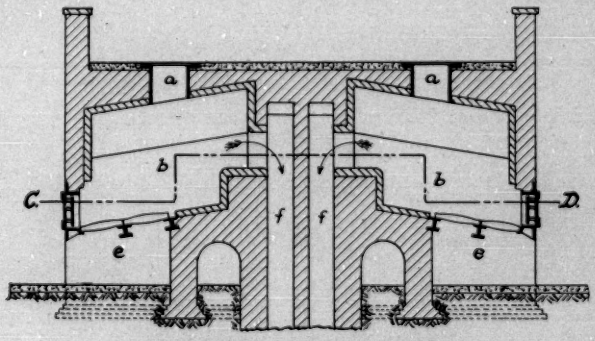
The destruction of waste by fire is as old as civilization




PLAN ON C. D.

FIG. 1 —The first English destructor, Manchester. Plan.

itself, but the process of burning in furnaces, as now practised, originated in England something like a quarter of a




SECTIONAL ELEVATION ON A. B.

FIG. 1a.—The original Manchester furnace. Section.

century ago, and has been continuously improved upon since that time up to the present day. About 1870, the sanitary conditions in many English towns became intoler-

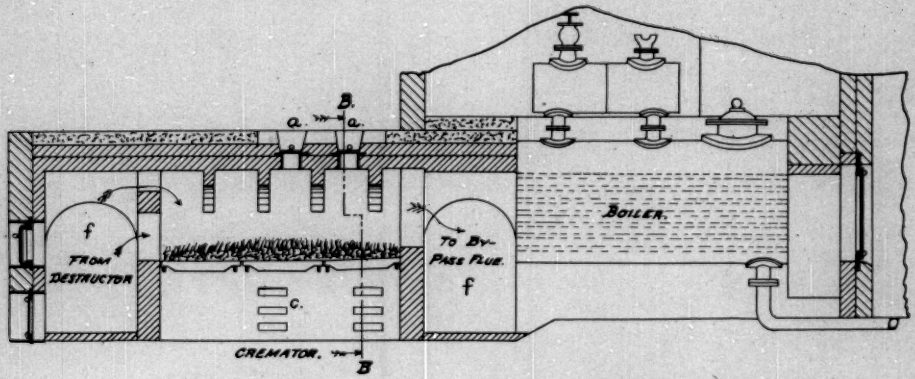



FIG. 2.—The Fryer destructor, 1876–77, and Jones fume cremator, 1883–84.

able owing to the accumulations of waste and refuse which for centuries had been dumped within the town limits, or upon the borders of the communities. A rapid and sani-

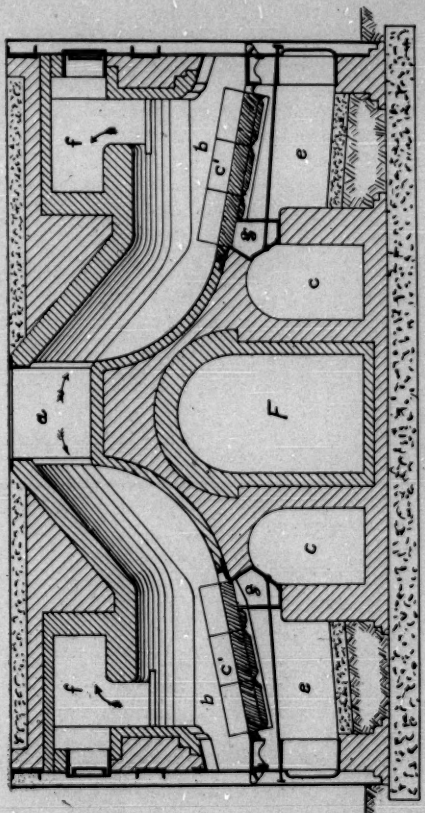



FIG. 3.—Horsfall destructor, 1888.

tary method of disposal was sought, and the first attempt at destruction by fire was made at Paddington, a suburb of London, by the erection of a crematory built by the

Messrs. Mead, dust contractors. This attempt was only partially successful, as the furnace operated badly by natural draft, and no provision was made for the prevention of the emission of odors and fumes resulting from combustion.

In 1874–5 a furnace which was afterward called a "destructor" was built at Manchester. In 1876, the construction of this Manchester furnace was imitated by Fryer, at Ealing, and the type continued at Birmingham, Leeds and Bradford, all of which cities installed destructors during the three following years.

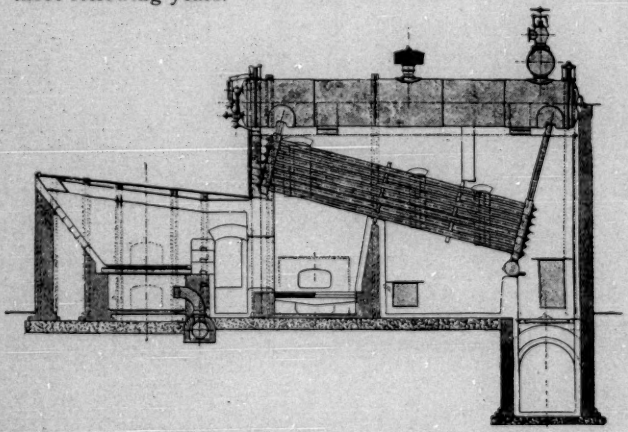


FIG. 4.—Beaman & Deas destructor, with boiler, 1893.

The weak point of the *Fryer Destructor* was that no provision was made for the destruction of the fumes. An improvement in this respect was made by Jones, of Ealing, who introduced a "fume cremator," consisting of a secondary fire situated in the flue leading from the destructor to the chimney. This was the first attempt made to render the operation of the furnace sanitary.

The next improvement was made by *Horsfall*, in 1887–88. The same type of construction was preserved, and the improvement consisted of a forced draft over and under the fire-bars, thus increasing the temperature and permitting

the introduction and use of a water-tube boiler in close proximity to the destructor; the arrangement of the flues and flue openings, and a new variety of fire-bars.

There were subsequently brought into use several other forms of destructors, which upon trial were found to be efficient and in many respects entirely sanitary, but which, for one reason or another, failed to reach popular favor. Among these were Healey's Destructor, the "Acme" Destructor of Messrs. Hart & Royle, Warner's "Perfectus," Mason's

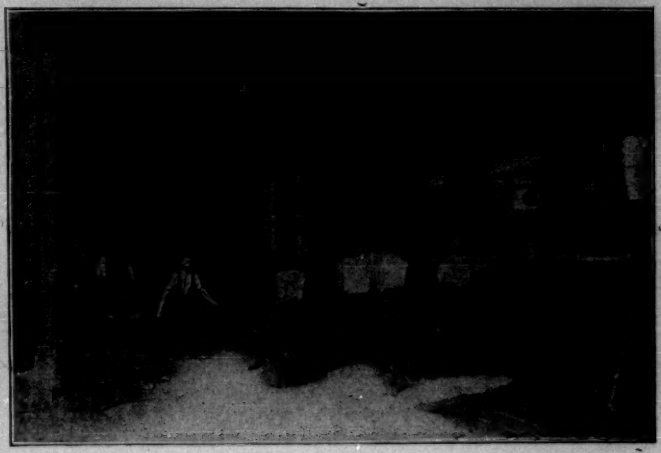


FIG. 5.—Beaman & Deas destructor, Darwin, England.

"Gasifier," and the combined Destructor of Messrs. Goddard, Massey & Warner.

*The Beaman & Deas Destructor*, which was brought out in 1893, was of the same type as its predecessors, a twin cell furnace connected with a water-tube boiler, and having forced draft under the ash-pits which raised the temperature to the highest degree yet attained and insured perfect combustion of the gases and the utmost power and efficiency. All these destructors, together with others not mentioned,

were of the characteristic English cell type, depending upon the alternate charging of each cell for the combustion of the gases and the utilization of the heat for the operation of the steam boiler.

In 1898 appeared an entirely different form of destructor called the "*Simplex*," invented and built by the Messrs. Meldrum Bros., Ltd., of Manchester.

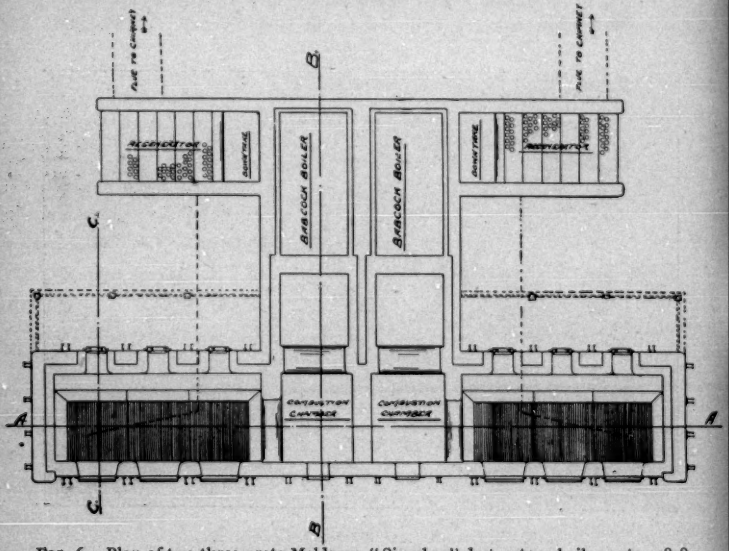



FIG. 6.—Plan of two three-grate Meldrum "Simplex" destructors, boilers, etc., 1898.

This destructor is a furnace of the modern type, and as compared with others is wholly original and novel in arrangement. It combines efficient, inoffensive cremation of refuse with the production of a maximum amount of steam power.

The furnace is practically one long cell, fed and clinkered through two, three or four separate openings, according to the number of grates installed.

The grates are arranged side by side, separated by dead-plates. The ash pit is divided into sections corresponding with the grates above, and each section is closed by air-tight doors. In this closed section of ash-pit, beneath the grate, are placed patent steam blowers, which deliver any desired pressure of forced draft up to 6 inches of water column, the average blast used being $\frac{1}{8}$ inch of water.

The charging of this destructor is done by hand-feeding through the fire-doors, or through charging-holes on the top of the furnace. The several grates are charged and clinkered in rotation; the gases and smoke from any one of the

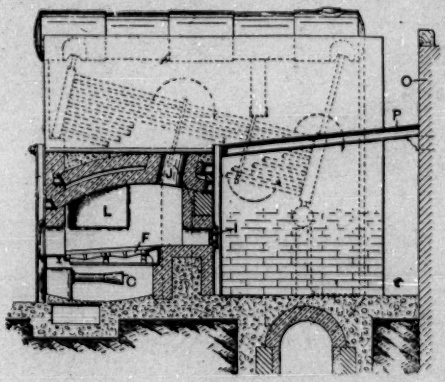



FIG. 7.—Cross section, Meldrum "Simplex" destructor.

freshly-charged grates are rendered innocuous by the action of the others, which remain at high temperature. If grate No. 1 be charged in small quantities, immediate ignition of the material is secured and the gases as distilled in their sideway motion must pass over and intermingle with the heated volume passing from Nos. 2, 3 and 4, the whole volume then entering the combustion chamber. This combustion chamber has a temperature of 1,800° to 2,700° F., which insures the perfect combustion of the vapors and products of cremation. After passing through the boiler, the hot gases are utilized in heating the air forced under the

FIG. 8.—Charging platform, destructor, Hackney, England.

FIG. 9.—Front of destructors, Hackney, England.

grates by means of an economizer or regenerative air heater, placed in the flue beyond the boiler. The temperature of this air, raised to 300° F., and supplied under the grates at a pressure of $1\frac{5}{10}$ inches water column, insures the rapid evaporation of all liquids and is a most important factor in the destruction of all combustible matter, the production and maintenance of the highest obtainable temperature, and the development of the greatest amount of steam power.

One of the main advantages of the Meldrum Destructor is its economy, for the large amount of heat developed may be attained by the use of the poorest kind of fuel—coal or coke dust, ash-pit refuse, ashes, anything, in fact, possessing calorific value.

### LATE IMPROVEMENTS IN DESTRUCTORS.

The really vital improvement, the cause of the rapid progress made in Great Britain in the last few years is the high temperature attained by the introduction of powerful currents of steam or heated air under the ash-pits of the furnace. In the old forms the temperature of the gases rarely reached more than 1,000 degrees, and it took nearly seventeen years of progressive work to bring the temperature to a point where complete combustion was attained without the emission of fumes and odors. In 1887 the temperatures ranged from 500 degrees to 750 degrees. In 1902, at Walker-on-Tyne, the temperature of 3,000 degrees was attained by a Meldrum Destructor.

The second important improvement in English practice was the use of steam boilers of large capacity in direct connection with the destructor, which utilized all the heat generated. A report of the examinations made by Lord Kelvin and Sir Douglas Fox (1896–7) shows that the Horsfall and Beaman & Deas Destructors evaporated from 1 to $1\frac{1}{4}$ pounds of water for every pound of waste consumed. The latest reports from Meldrum Destructors operating at Nelson, England, show that in 1892 1·95 pounds of water were evaporated for each pound of mixed town's refuse consumed.

*The steam power* thus developed, a valuable element of economy in the management of municipal affairs, has been

widely utilized by the cities and towns of Great Britain during the past five years. It has been applied as auxiliary in the production of electrical power in no less than sixty-three cities; and this power has been utilized in connection with the sewage-pumping works in about forty towns. In several instances the water supply of a town has been pumped by the aid of the power derived from the incineration of the town's refuse. To sum up, of the one hundred and eighty places in Great Britain where destructor plants are installed, over one hundred of them are combined with the electricity or sewage works.

There are no reasons why the best forms of English destructors are not adapted to the conditions of disposal work in this country. It is true that English municipal waste contains a larger proportion of ashes, clinkers and cinders, a smaller proportion of garbage containing moisture, and a less amount of combustible refuse, or rubbish, than American city waste, but, on the other hand, American municipal waste, although it contains a larger proportion of garbage, which carries a higher percentage of moisture than the English, has an ash collection which contains from 17 to 25 per cent. of unburned coal, and has also a refuse, or rubbish, collection which is three times as great as that of the English towns.

Taking the average percentage of each, and calculating the calorific value of the waste of American cities as compared to that of the waste of English towns, there is no reason to doubt that the destruction of our waste in furnaces of the English type may be achieved successfully without the use of fuel, the heat values being made up in one direction when they are lacking in another owing to the variance in the nature of the waste.

In illustration of the operation of English destructor plants consuming unseparated municipal waste the following reports, covering a period of three years, taken from three separate installations, will be found of interest:

DARWEN REFUSE DESTRUCTOR.

Duration of test, 48 hours continuous.
State of weather: very heavy showers—rainfall ·92 inch on Friday, and ·16 inch on Saturday.

| | |
|---|---|
| Total quantity of refuse destroyed | 63·88 tons. |
| Description of refuse: unscreened ash pit refuse, 61·88 tons; slaughter-house and fish-market offal, 2 tons; the average percentage of moisture being 35 throughout the refuse. | |
| Total weight of clinker remaining . . . . 19½ tons = | 30·6 per cent. |
| Temperature of feed water (average) | 185° F. |
| Water evaporated per pound of refuse (actual) | 1·48 pounds. |
| Water evaporated per pound of refuse (from and at 212°) | 1·56 pounds. |
| Average steam pressure per square inch | 183 pounds. |
| Average temperature of combustion chamber | 1,631° F. |
| Highest temperature of combustion chamber, over (Copper melted five times.) | 2,000° F. |
| Lowest temperature of combustion chamber | 1,201° F. |
| Average temperature of flue after leaving boilers | 703° F. |
| Average temperature of flue after leaving regenerator, | 585° F. |
| Average temperature of feed air from regenerator | 328° F. |

*Extract from figures of test made at Nelson, December 20, 1900.*

| | |
|---|---|
| Duration of test | 9½ hours. |
| Grate area of cells | 100 sq. feet. |
| Heating surface of boiler, one Lanc. type, 30 x 8 feet | 986 " |
| Refuse consumed per hour | 5,703 pounds. |
| " " " square feet of grate per hour | 57 " |
| Water evaporated per hour from and at 212° F. | 8,650 " |
| " " " pound of refuse from and at 212° F. | 1·516 " |
| Average percentage of $CO_2$ | 12·21 per cent. |
| " temperature of combustion chamber | 2,200° F. |
| Percentage of clinker | 21·18 per cent. |

NOTE.—The boiler was not clothed when this test was made.

*Extract from figures of test made at Nelson, April 25, 1901.*

| | |
|---|---|
| Duration of test | 8 hours. |
| Refuse burned per hour | 6,853 pounds. |
| " " " square feet of grate per hour | 68½ " |
| Water evaporated per hour, from and at 212° F. | 13,442 " |
| " " " pound of refuse from and at 212° F. | 1·96 " |
| Water evaporated per square feet of heating surface from and at 212° F. | 13·6 " |
| Average percentage of $CO_2$ | 14·40 per cent. |
| " temperature of combustion chamber | 2,227° F. |
| Percentage of clinker | 29·06 per cent. |

NOTE.—The boiler was covered with non-conducting composition.

*Extract from figures of test made at Lancaster, February 7, 1902.*

| | |
|---|---|
| Duration of test | 12 hours 26 minutes. |
| Grate area of cells | 100 sq. feet. |

| | |
|---|---|
| Type and size of boiler | Lancashire, 30 x 8 feet. |
| Water evaporated per hour from and at 212° F. | 9,820 pounds. |
| Water evaporated per pound of refuse from and at 212° F. | 1·63 " |
| Average percentage of $CO_2$ in flue gases | 15·50 per cent. |
| Average temperature of combustion chamber, (Copper could always be melted.) | Over 2,000° |
| Average temperature of heated air from regenerator | 478° F. |

## WOOD PULP POLLUTION OF STREAMS.

The United States Geological Survey renewed, at the beginning of the Bowdoin College year, arrangements with Prof. Franklin C. Robinson for further co-operative work. The task set for Professor Robinson under the existing agreement will be somewhat different from that formerly performed by him. Under the previous agreement Professor Robinson took water samples from the Androscoggin River above and below Rumford Falls, Livermore Falls, and Lewiston, and above Brunswick, and on Penobscot River above and below Bangor. This arrangement resulted in the collection of results in twenty-five analyses, nineteen on the Androscoggin and six on the Penobscot. They show, in a satisfactory manner, the character of the water in these rivers during the summer and winter seasons, but give no conception of the effect of the extensive pulp pollution during dry summer seasons. The work which it is now proposed to undertake will be directed toward a definite determination of the effect of wood-pulp wastes upon natural waters. The problem is a broad one, and is receiving considerable attention in those parts of the United States where pulp mills have been located, and it is obtaining especially prominent notice in the vicinity of Lake Champlain. The plans made contemplate a precise determination of the character of sulphite and soda-pulp wastes and their stability. It is important to know whether this waste is of itself highly putrescible, or whether it has characteristics similar to those of straw-board waste, being stable itself, but affording abundant opportunity for the decomposition of matters brought into contact with it.

When the nature of the pulp waste has been determined, experiments will be made for the purpose of showing how it persists in its effects as it is diluted and carried down stream. Already the facts which have been gathered with reference to this point have proved interesting, notably one in connection with the effect of waters polluted with pulp-mill wastes upon aniline dyes. A complaint was received some time since from an official of a woolen mill in the city of Lewiston, which stated that, if Androscoggin River water were used for washing materials that had been dyed with aniline dyes, the color of the goods was destroyed and considerable loss was thereby sustained. It was stated that all colors that had been used in the dye-house were equally affected, and that all, after washing, had a reddish cast.

The investigation of the pulp pollution, with the investigation of straw-board waste, will furnish a valuable set of data concerning the whole subject of paper and board manufacture.

## THE "TECHNOLEXICON" OF THE SOCIETY OF GERMAN ENGINEERS.

The Editor-in-Chief, Dr. Hubert Jansen, gives the following short report on the work done up to February, 1904: The universal technical dictionary for translation purposes, in English, German and French, the compilation of which was begun in 1901 under the auspices of the Society of German Engineers, has received help up to the present time from 353 technical societies at home and abroad; 51 of these are English, American, South African, etc., 274 German, Austrian, and German-Swiss, and 38 French, Belgian, and French-Swiss societies. Of firms and individual collaborators 2,573 have promised contributions.

The excerption of texts in one, two or three languages (handbooks, pamphlets, business-letters, catalogues, price-lists, etc.) and of the existing dictionaries has yielded 1,920,000 word-cards so far. To these will be added within the next two years (by the middle of 1906) the hundred thousands of word-cards that will form the result of the original contributions—those already sent in and those still expected—of the 2,573 collaborators at home and abroad, when the editors in Berlin have finished them for the press. Specially made handy note-books had been placed at the disposal of the collaborators to write their collections in, of which 317 have come in filled so far.

The outstanding contributions were called in by Easter of this year, 1904, unless a later term had been especially arranged with the Editor-in-Chief. As the printing of the "Technolexicon" is to begin in the middle of 1906, delayed contributions will continue to be received and utilized as far as possible.

The Editor-in-Chief will be pleased to give any further information wanted. Address: "Technolexicon," Dr. Hubert Jansen, Berlin (NW. 7), Dorotheenstrasse 49.

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## PETROLEUM BRIQUETTES FOR FUEL.

A new process of manufacturing petroleum briquettes has been invented by M. Maestracchi, so Mr. Oliver J. D. Hughes, the United States consul-general at Coburg, reports. The process is a simple one, consisting of mixing petroleum with three other chemicals in the following proportions: Petroleum, 1 liter; soft soap, 150 grains; resin, 150 grains; caustic soda lye wash, 300 grains. This mixture is then heated and well shaken, after which it is allowed to solidify. This operation occupies about forty minutes. Care has to be observed to prevent the liquid running over, and this is achieved by pouring a small quantity of soda into the vessel and shaking it well until solidification is completed. The mixture is then run into briquette molds of the requisite size, and these are then submitted to a furnace heat for ten or fifteen minutes. The briquettes are then set aside to cool, which occupies an hour or two, and then they are ready for use. If it is desired to make the briquettes more solid, this can be accomplished by the addition of sawdust or sand to the mixture. Experiments have demonstrated that these briquettes yield three times as much heat as ordinary coal; they are lighter in bulk and easier to carry; and what is more important, after consumption, there is very little ash or other residue.

## Mechanical and Engineering Section.

*Stated Meeting, held Thursday, October 22, 1903.*

# Modern Expanding and Flanging Machinery and Tools.

By Luther D. Lovekin,
Chief Engineer, New York Shipbuilding Company, Camden, N. J.

In presenting this subject before the Institute this evening, it is my intention to describe the machinery, tools and methods of operation as fully as possible, so as to enable my hearers to see for themselves the many advantages possessed by them, both in regard to labor saving and the wear and tear incident to such machines and tools.

Attention was first called to the writer on the subject during the year 1889, while employed with one of the largest shipbuilding establishments in the United States.

Noticing the great amount of labor in placing the flanges on copper pipe, I decided to make an experiment in order to place on the market a new type of joint which I had previously invented (of a much cheaper manufacture, if successful). This, however, could not be done, owing to existing laws in the United States inspection service, so I turned my attention to the making of joints already in use.

My first experiments were with 8-inch copper pipe. In order to avoid excessive expense I used a large lathe we had in the shop, and revolved the pipe, the roller being held in tool post on a suitable arm. This method proved most satisfactory, and convinced me that it was time to work in this direction if one wanted to see the copper shop running on an economical basis, similar to other shops.

There was one thing that struck me most forcibly, and that was the lack of any improved machinery in our copper shop; I presume the idea being that no improvements were needed. Seeing this state of affairs I decided that it was the best field that I could cultivate, and, accordingly, I designed the experimental machine shown in *Figs. 1* and *1a*.

With this small hand-crank machine I turned out the first sample of a new departure in the coppersmith's art—

of rolling the pipe into the flange and beading it over; in other words, I perfected the joint in the machine to such an extent as to place it beyond any possible criticism.

The next test I made was that of tightness. Prior to my

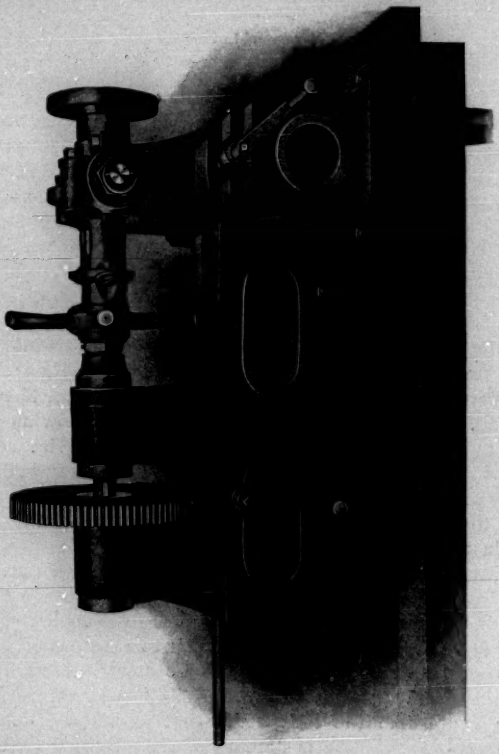

FIG. 1.—Experimental expanding machine (side view).

machine-made joint it was impossible to secure a tight joint without resorting to brazing the flange on the pipe, a method which has proven for years past to be most destructive to the copper, and which has been the cause of many

failures in copper steam pipes, resulting in considerable loss of life. So I had a few samples made and tested according to my idea, with the result that in every case the

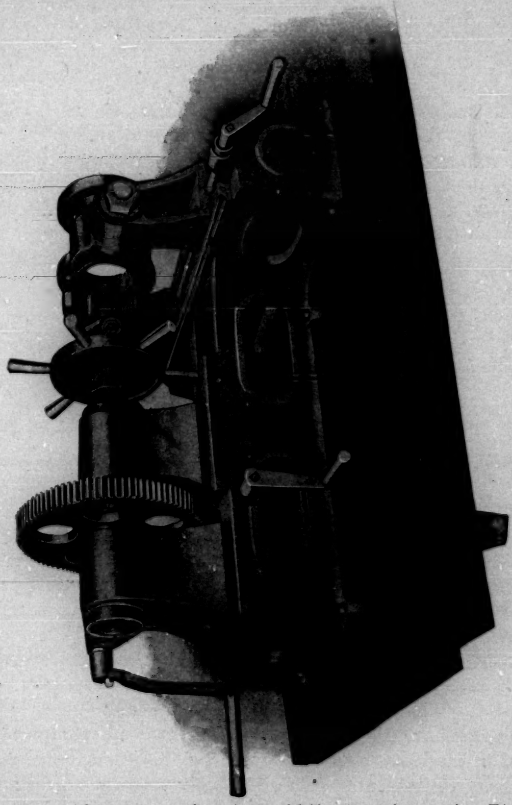

FIG. 1a.—Experimental expanding machine (side view).

pipe would rupture in the middle (as shown in *Fig. 2*, due to the copper having reached its limit of tensile strength) without showing any signs of leakage up to a

pressure of from 1,500 to 2,000 pounds. The pipe tested was 4 inches in diameter and $\frac{1}{8}$ inch thick, and by formula

$$\frac{P \times D}{2 - T}$$

we found the copper good for a tensile strength of

$$\frac{2000 \times 4}{\cdot 25} - 32{,}000 \text{ pounds},$$

which is about what we expected. *Fig. 2a* shows method of flanging the above-mentioned pipe in section.

A similar pipe was then tested, this pipe having been put in the flange by means of peneing, or, as we will call it, the "old method;" *Fig. 2a* also answers for this illustra-

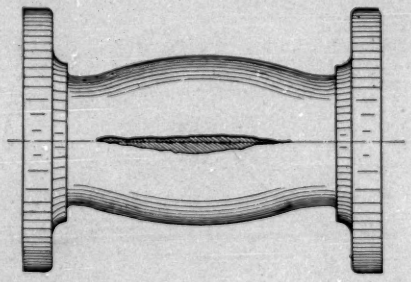

FIG. 2.

tion, the flange being bored out similar in each case, and then in addition this pipe was brazed to the flange. This pipe stood the test up to 1,200 pounds and then began leaking back of the pipe around brazing.

It is worthy of mention to note that with this hand-crank machine the flange was rolled in completely in ten minutes, while it took two hours to hammer the other sample in, without mentioning the fact that no comparison could be made as to the appearance of the work, the sample made by the machine being perfectly smooth, uniform in thickness and no flaking; while the one hammered in showed hundreds of indentations from the ball-faced hammer used for such work, no uniformity in thickness and

considerable flaking, without mentioning the fact that the flange had become so distorted in hammering the pipe into same as to necessitate it being refaced. This latter trouble nearly always exists, especially so in high pressure work, and is the result of the continual battering with the hammer inside the pipe.

Thousands of dollars are expended annually owing to such crude methods being employed.

The following is a brief description of the present methods employed in most copper shops throughout the country, together with a comparison of the work necessary when using the machine and tools:

In order to connect the flange and pipe at the present

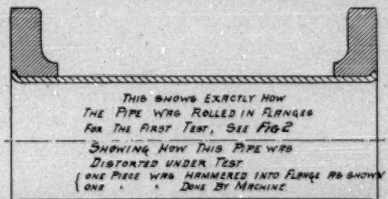
THIS SHOWS EXACTLY HOW
THE PIPE WAS ROLLED IN FLANGES
FOR THE FIRST TEST, SEE FIG 2
SHOWING HOW THIS PIPE WAS
DISTORTED UNDER TEST
ONE PIECE WAS HAMMERED INTO FLANGE AS SHOWN
ONE " " DONE BY MACHINE

FIG. 2a.

time, flanges are made and *turned on the face and bored*, after which the copper pipe is entered into the same and hammered by hand, so much as to distort the flange in almost every case. This, however, does not form a tight joint, and in order to prevent leaking of same, brazing has to be resorted to, which, as is a well-known fact, materially decreases the strength of the pipe, inasmuch as it destroys the properties of the copper and also warps and twists the flanges, due to their being heated.

After this is finished, another expense is added. The pipe is then taken to the machine shop and placed on a boring and facing machine, to be faced up, and the amount of time necessary to reface this flange complete depends

entirely on the shape of the pipe and the size of same, a 4 inch pipe requiring anywhere from one to two hours to complete said work. This amounts to several thousand dollars a year, and when finished it will not begin to compare with that done by the machine.

With the machine-made joint the flange is bored and faced, placed in the machine, pipe entered and clamped, and the operation completed in about ten minutes for a 4-inch pipe, the expanding, as well as the flaring, being perfect; and inasmuch as we can see the effect of the tool marks on the copper, we know the danger of leaking is no more than that of a boiler tube where we resort to expanding alone.

I believe the law compelling the brazing of pipes was originated on account of the impossibility of securing tight joints with high pressure, leakage occurring between pipe and flange on the outside; but with tests which we have conducted with our machine-made joint, brazing is not necessary. There is no comparison as to neatness, efficiency and cost of production, and if brazing is required it can be done very readily from the back of the flange, without destroying the face.

I will now describe the new list of machines and tools which are being placed on the market to do this class of work in the most approved manner, with a saving that will startle the proprietors of all such establishments where these old methods prevail.

The machines and tools were designed to meet the demands of shipbuilders and engineers generally, where a large amount of wrought iron, steel and copper piping is required to be expanded tightly in the flange as well as beaded over the same, thus dispensing with the common practice of screwing or peneing by hammer flanges on pipe, especially so when such pipes are subjected to the action of salt water or to any vibration.

It is well known that there is considerable wrought iron used in connection with the bilge and ballast system, sounding tubes and air pipes of vessels, all of which have given considerable trouble due to using the threaded pipe.

These machines and tools, illustrated, were designed with

a view of doing work of such a character as to avoid these troubles. When we consider that the piping throughout ballast tanks is usually made of wrought iron for salt water, and has a thread cut on same to receive the flange, it is evident that the life of a pipe is simply a matter of short duration, as it will corrode at the bottom of the thread first, and is a continuous source of trouble; while with our method the thickness of the pipe remains uniform throughout, and can therefore be a much lighter gauge for the same lasting qualities. Again, the immense extra weight of piping carried on ships or even in our large buildings, which becomes necessary when screwed piping is used in order to get the proper thickness at the bottom of the thread, is fully 20 per cent. more than necessary for the same lasting qualities.

THE LOVEKIN EXPANDING AND FLANGING MACHINE FOR PIPES, 2 INCHES TO 7½ INCHES INCLUSIVE—CLASS "A" SIZE.

The above-mentioned machine consists of a cast-iron base (as shown in *Figs. 3* and *3a*), having at the rear end a motor for driving the same, or it can be driven from countershaft overhead. The motor drives the machine by means of a belt to the cone pulleys (as shown), so as to permit of variable speeds being used, or by means of countershaft overhead provided with cone pulleys, in case the motor is not desired.

This shaft on the machine is provided with a worm which engages in a worm wheel, suitably housed on the rear end of the machine. The worm wheel has a long sleeve cast on the same, and is also provided with a round collar or nut at the extreme end of this sleeve. The worm wheel and its sleeve are free to revolve; the inner bore of this sleeve is provided with a key-way, so as to allow the central or driven shaft to move freely forward and backward as desired, and the feather transmits the power to the central or driven shaft, causing it to revolve.

This worm and worm wheel, together with their brackets, all form a fixed part of the machine, with relation to the driving mechanism. The central shaft passes through

the worm wheel and is made to form a socket for all sizes of tools at the forward or front end of the same. This man-

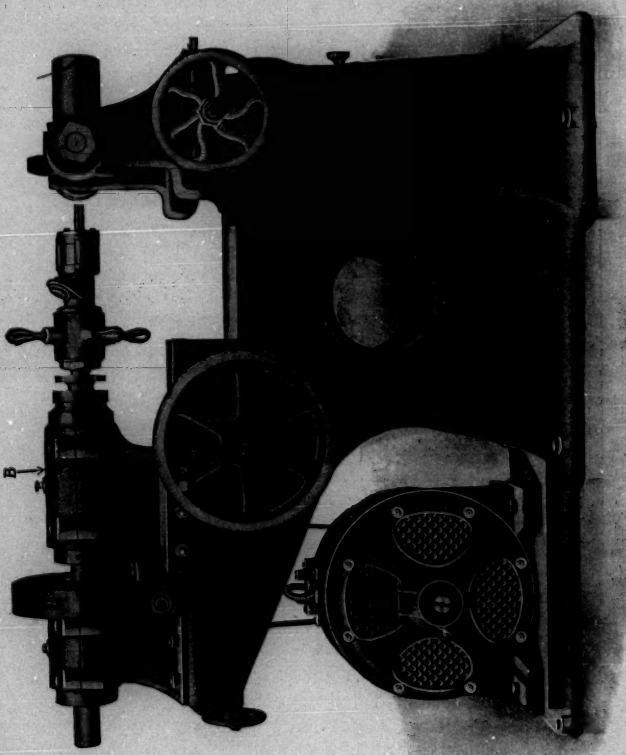

FIG. 3.—The Lovekin expanding and flanging machine (side view).

drel is provided with collars, and thrust or anti-friction rings at the front end, and a round nut at the rear end of

movable bracket *B*, as shown in cut, *Fig. 3*. This enables the shaft to revolve freely in this movable bearing, but it

FIG. 3a.—The Lovekin expanding and flanging machine (side view).

cannot move unless bracket *B* is advanced. This bracket *B* is made with adjustable guides at the sides, and is also

provided with a nut underneath, through which passes a lead screw. The lead screw is provided with bevel wheels of suitable size, and located to suit the best position of the operator in charge.

The lead screw is used to move the head *B* to and from the work to be operated on as desired, the head *B* having the shaft held in same that forms the socket for all tools. Thus it will be seen that all the forward and rearward movement necessary for the various sizes of pipe is obtained by means of this sliding bracket *B*. In addition, the central shaft revolves in this bracket; and to provide for the end thrust on this bracket the lower edges are provided with good and substantial guide strips, thus preventing any tendency to lift up, due to this end thrust.

The central shaft is provided with large head at the front end, so as to form a large surface for anti-friction collars placed between the bracket and the shoulder on center shaft, thus reducing the friction to a minimum.

The front portion of machine, as shown in *Fig. 3a*, consists of two sliding heads mounted on suitable guideways on the base of the machine. These heads have a right- and left-hand screw, passing through nuts on the underside of the same, and causing said heads to move from each other at equal distances from the center. The heads are made of cast iron, and are fitted with detachable clamping jaws of cast iron. These jaws are also provided with tool steel "V" grips, for holding the pipe centrally and preventing from turning while being expanded.

The cast-iron jaws are made with grooves of suitable size, to permit the flange being held in the same, independent of the pipe. These grooves are faced on the rear side, so as to be in perfect alignment with the central shaft. This permits the flange being placed exactly in line as desired; and at the back ends suitable set screws are located, so as to force the faced portion of the flange against the faced portion of the jaws. The backs of flange being rough castings, and at times having bosses on the back, make this method of securing the best possible after years' experimenting.

The machine is also provided with suitable locker and shelves at the front end. These will be found useful for stowing small parts.

(*To be continued.*)

## STORING COAL UNDER WATER.

In connection with the experiments of the British Admirality on the storage of coal under water for the purpose of retaining the calorific value of the fuel, some interesting information upon this subject has been vouchsafed by Mr. J. Macaulay, the general manager of the Alexandra Docks and Railroad of Newport. He recovered a quantity of coal that was known to have been submerged in the docks under his control for periods varying from three to ten years, and also further quantities from the estuary of the River Usk, whither the fuel had been carried by currents and tides from wrecks in the Bristol Channel. The latter coal was considered to have been for more than two years under water. This coal was experimented with upon the locomotives employed at the docks in competition with the best freshly mined coal obtainable. The trials were carried out under similar conditions so that absolutely comparative data might be obtained. The results showed that the first place was taken by the river-submerged coal, followed by that which had lain submerged in the docks for ten years, with the newly mined coal third. According to this expert, coal loses about 10 per cent. of its steam-generating power when stored in the open air for any great length of time, the greater part of this deterioration taking place during the first year. From these tests it is apparent that the best method of storing coal with a high calorific value is under water, if it is to be stored for any great period. Subaqueous storage is cheap, and has the further two important advantages, of immunity from hostile attack, and ready access when required, and it permits the utilization of a great space for other purposes that would otherwise be occupied by the bunkers of coal on land.—*Engineering and Mining Journal.*

## OBTAINING METAL POWDERS BY AN ELECTROLYTICAL METHOD.

Prof. A. Zamboni (*Elettricità* No. 4, 1903) has succeeded in obtaining aluminum, sodium, potassium, etc., amalgams, decomposable in water. His method is based on the fact that when electrolyzing a solution of metallic compounds by means of a mercury cathode, the corresponding amalgam is obtained; this process may be applied even to such metals as are commonly regarded as unamalgamable, such as, for instance, platinum and iron. The amalgams thus obtained are spongy substances, filled with mercury particles, and have specific weights between those of mercury and the corresponding metal. By compressing in linen bags the amalgam thus economically obtained, nearly pure mercury will be obtained, the amalgam undergoing a partial decomposition, when a readily pulverized substance will remain, made up of amalgam and metallic powders. If this mass be distilled at a temperature below the melting point of the amalgam, the mercury is found to separate from the metal (especially in the case of iron and related metals), whereas the

latter remains in a spongy, friable state, being capable of reduction, when pounded, to extremely fine powder. When choosing for this distillation convenient atmospheres, different metallic compounds will be obtained. If, for instance, iron amalgam be distilled in a reducing medium, pyrophoric iron will be obtained, susceptible of being converted into common iron by a convenient treatment. Oxidizing atmospheres will give some so far unknown iron oxides and protoxides.

The above process was found in the course of an investigation of the Edison accumulator; it was originally intended to afford a ready means of preparing ferric oxide.—*Scientific American.*

## NEW RAILWAY UP VESUVIUS.

Messrs. Thomas Cook & Son have just constructed a new electric railway up Vesuvius from Pugliano, the northern quarter of Resina, to the terminus of the old funicular railway, which was made up the cone to the crater twenty-three years ago. This new line is nearly 4¾ miles long. Except for a section in the middle, it is laid with a ruling gradient of one in 12½, and the cars run by adhesion. In the middle portion the gradient rises to one in four, an incline as great as that of the Righi line, and in consequence it has been necessary to use a rack rail, the Strub system having been selected, as on the Jungfrau railway. On this rack-rail section the cars are pushed up by a four-wheel locomotive provided with two 80 horse-power motors, and fitted with an elaborate system of ordinary and emergency brakes. On the other sections the cars, which seat twenty-four passengers and can accommodate six more on the platforms, are propelled by their own motors, the current being supplied through overhead trolleys, as is also the case for the rack-line locomotives. The generating station stands at the foot of Monte Cateroni, close to the point where the rack-rail section begins. Pugliano is already connected with Naples by electric tramway, with the exception of a short length which has still to be finished, and the old funicular line up the cone has been reconstructed and equipped for electrical working; hence it will soon be possible to travel by electricity all the way from Naples to within 250 yards of the crater, a good deal more quickly and comfortably than is permitted by the present means of transport.—*Scientific American.*

## NEW ENGLAND WATER POWERS.

New England water powers are being prospected with a good deal of system with the purpose of developing them for electric purposes. The possibilities contained in the rivers of these States are considered to be tremendous, in view of the rapid progress which long-distance transmission of electric power is making. Not a few New England manufacturers look to see the undeveloped and neglected water power of the section make up, to a considerable extent, for the distance from the coal mines, which is the chief disadvantage of manufacturing in the Northeastern States of the Union. In a country that is either mountainous or at least hilly in practically every section, reservoir sites may be found in plenty to provide against the times of low water, which is the chief drawback of the water power of New England as already developed.—*Iron Age.*

# PHYSICAL SECTION.

*Stated Meeting, held Thursday, December 17, 1903.*

## Osmotic Pressure.

By George A. Hoadley,
Member of the Institute.

About the middle of the eighteenth century Abbé Nollet demonstrated the existence of osmotic pressure by closing the lower end of a glass tube with a diaphragm of animal membrane, and, having placed alcohol in the tube, submerging the lower end in water, to such a depth that the hydrostatic pressure was the same without the tube as within it. This membrane prevented the passage of the alcohol through it, but allowed pure water to pass through freely, and only a short time was needed to demonstrate that the liquid within the tube was increasing in volume.

The same result is secured when an animal membrane separates a solution from its solvent. While investigating these phenomena in 1867, Traube devised a form of diaphragm called a semi-permeable membrane. This membrane consisted of an artificially prepared precipitate of copper ferrocyanide, the support being a vegetable parchment stretched over the end of a glass tube.

Though they had the property of permitting the solvent to pass through them freely, while the substance could not, these supports did not possess the rigidity necessary to withstand any considerable pressure.

In order that he might secure enough material strength in the support of the semi-permeable membrane, not only to show the existence of osmotic pressure, but to attempt its measurement, Pfeffer, in 1876, formed this membrane in the walls of unglazed porous cups by placing these cups in a solution of copper sulphate and then filling them with a solution of potassium ferrocyanide. The two substances in solution enter the walls of the cup from opposite sides and form a precipitated semi-permeable membrane of copper

ferrocyanide. This appears as a fine brownish line in the walls of the cup, and when once formed prevents the further passage of either substance. It does, however, permit water

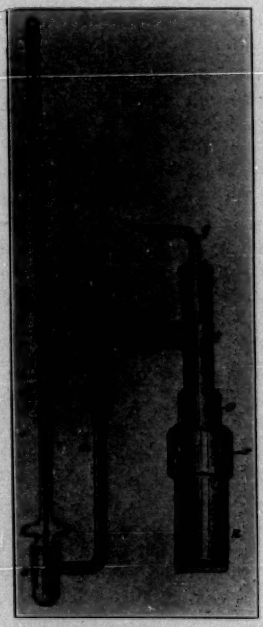

FIG. 1.

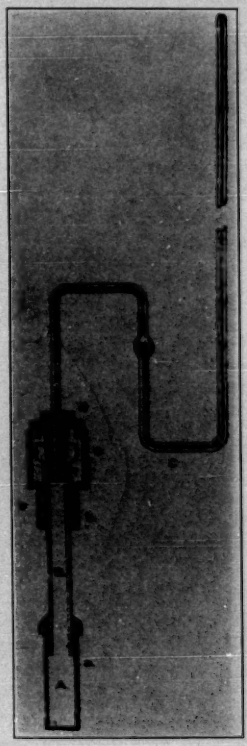

FIG. 2.

to pass through, and on this depends its value for the study of osmotic pressure.

The form of apparatus used by Pfeffer is shown in *Fig. 1*. In this *z* is the cup connected to the manometer by the glass

tubes *t* and *v*, and the collar *r*. The cup, which was of unglazed porcelain, was 46 millimeters high and 16 millimeters in diameter, while the manometer was 24 centimeters high. After being filled with the solution, the osmotic pressure of which was to be determined, the whole apparatus was submerged in a glass tank containing distilled water. The method of taking the temperatures and manometer reading is indicated in *Fig. 2*.

FIG. 2.

By far the most satisfactory work that has been done in the measurement of osmotic pressure has been carried on at the Johns Hopkins University by Prof. H. N. Morse and his associates.

What Professor Morse set himself to do was: to find some efficient way of getting rid of the air in the pores of the cups, since its presence is likely to make the semi-permeable

membrane discontinuous; to devise a quicker and more satisfactory way of forming the membrane in the walls of the cup; and to provide a form of apparatus that would withstand mechanically the enormous pressures developed.

The solution of the first and second of these problems has been satisfactorily accomplished, and very substantial progress has been made toward the solution of the third. In order to free the walls of the cup from air, advantage has been taken of the endosmose that results when a current of electricity is sent through a porous partition separating two electrolytes. On filling the cup nearly full with a boiled solution of potassium sulphate, immersing this cup in a beaker of the same solution and sending the current from the electrode surrounding the cup to the one within it, the current is accompanied by the passage of a considerable quantity of water through the wall into the cup, and this movement of the water sweeps the wall free of air.

This process requires about an hour, and 300 cubic centimeters of the contents of the cup frequently need to be removed in order to keep it from overflowing. To form the semi-permeable membrane the cup is placed in a beaker and surrounded by a cylindrical electrode of sheet copper. A platinum rod is placed in position inside the cup for the other electrode. Connection is made with a dynamo giving as high as 110 volts with the positive pole connected to the copper electrode. A tenth normal solution of copper sulphate is poured into the beaker while a tenth normal solution of potassium ferrocyanide is poured simultaneously into the cup. Endosmose takes place rapidly at first, but gradually decreases as the membrane is formed, while the electrical resistance increases until it reaches 2,000 ohms in ordinary porous cups, and as high as 200,000 ohms in hard burned cups.

In using this form of cup for the measurement of osmotic pressure it was found that the main difficulties to be overcome were of a mechanical nature. In order to secure the requisite strength of the connections certain devices were employed which are shown in *Fig. 3*.

*A* is the cup containing the semi-permeable membrane.

At the upper end there is placed between the inner wall of the cup and the porcelain tube *B*, a hard rubber or soapstone ring. This is turned to fit a groove cut in the inner wall of the cup with a carborundum wheel, and is cemented into place with a cement of litharge and glycerine. The upper surface of this cement is rendered impervious to the solvent in which the cup is immersed, by a coating of a solution of rubber and paraffin in carbon bisulphide.

The porcelain tube is ground to fit the inside of the ring with great exactness, and the ring is fixed upon it with shellac before it is fastened into the cup. To fasten the tube and ring into the cup a quantity of shellac is placed in the space above the ring at the top of the cup and the temperature is raised until the shellac melts. The cup and tube are then placed in a hot-air bath and baked until the shellac and rubber cement are hard.

The upper end of the porcelain tube is ground on the inside to receive a rubber stopper, through which passes the lower end of the manometer tube *C*. In order to keep the pressure from forcing this tube out of the stopper it is pushed through to a distance of about 3 centimeters and is then heated to a temperature above the melting point of shellac. By applying the gum a ring is melted around the tube, which, after cooling, effectually prevents its passing out of the stopper.

The stopper is kept in place by a brass screw-cap, *d*, that is threaded to fit the collar, *e*, which is kept in place by a flange fitting over a companion flange on the collar, *b*.

This collar is itself threaded to fit a tube, *a*, that is cemented to the porcelain tube under the enlarged upper end.

Professor Morse reports the experiment that gave the maximum pressure as follows: Resistance of the membrane not exactly known, but over 200,000 ohms. Solution of sugar N / 100 with respect to potassium ferrocyanide, and the water in which the cell was immersed N / 100 with respect to copper sulphate. The solution of sugar fresh and free from invert sugar. Cell set up at 5 P.M. Pressure at 5.10 P.M., 7·89 atmospheres; at 6.45 P.M., 31·41 atmospheres

(corrected). Temperature, 24·9°. Shortly after the second reading the glass tube was shattered.

From these results it is predicted that the osmotic pressure of a half-normal solution will be found to lie between 13 and 14 atmospheres at 20°, and probably between 13·4 and 13·8 atmospheres, while it is certain that for normal solutions of sugar it is not less than 31·4 atmospheres.

It will be observed that the experiment terminated by the breaking of the glass tube. It was the continued breaking of these tubes that led to the adoption of the porcelain tubes as described above. The necessity for great strength in every part of the apparatus is evident when we consider that the pressures obtained in this experiment are such as would be caused by a column of granite of uniform cross-section and a height of 423 feet.

SWARTHMORE COLLEGE,
December 17, 1903.

## ERICSSON'S LOCOMOTIVE "NOVELTY" DISCOVERED.

An interesting railroad relic, reminiscent of the first days of the steam locomotive, has been discovered in the North of England. The Liverpool and Manchester Railroad Company, the first public road constructed, it will be remembered, inaugurated a competition in the latter part of the twenties of the past century for a locomotive, in which Stephenson and other inventors participated. Three engines—the "Rocket," by Stephenson; the "Sans Pareil," by Hackworth; and the "Novelty," by Braithwaite and Ericsson, respectively—participated in the trials that were carried out in 1830. As is well known, Stephenson's "Rocket" secured the award of $2,500 which was offered, as being the most suitable engine, attaining a speed of 29 miles per hour. The "Sans Pareil" was second with a speed of 23 miles per hour, while the "Novelty" withdrew from the trials owing to the joints of the boiler giving way when the locomotive had traveled only 3 miles. Both the "Rocket" and the "Sans Pareil" are now preserved in the South Kensington Museum, but the "Novelty" mysteriously disappeared and was never found again until quite recently. It appears that Ericsson was so mortified by the failure of his conception, that he left it with his friend, Mr. Melling, who possessed engineering works located upon a space adjoining the Rainhill Station. These works were subsequently dismantled and the premises were occupied by the Rainhill Gas and Water Company. The "Novelty" was thus lost sight of, but it has now been recognized working as a stationary engine, the wheels having been removed for this purpose, and its identity thus somewhat disguised. Attempts are to be made to secure this third premier locomotive, and to place it alongside of its two contemporaries in the South Kensington Museum.—*Scientific American.*

# Mining and Metallurgical Section.

## Volcanic Origin of Oil.

By Eugene Coste, E.M., Toronto, Ontario, Canada.

[Communication to the Secretary, in discussion of the paper of Robert T. Hill, Washington, D. C., on "The Beaumont Oil Fields, with Notes on other Oil Fields of the Texas Region,"* presented at a joint session of the Franklin Institute and of the American Institute of Mining Engineers, Philadelphia, May 15, 1902.]

In a recent paper† I took exception to the opening paragraph of the above paper of Mr. Hill, in which he says: "In endeavoring to interpret the geological occurrence of oil, the geologist is confronted by the fact that science has not yet solved the problem of its origin, which lies at the root of the subject. . . . For the present we must consider oil as a material in the rocks, the origin of which is still unexplained."

I take this second occasion to re-enter our objection to the above statement, as well as to the following similar statement of Messrs. Hayes and Kennedy in their recent bulletin‡ on these same oil fields: "The origin of petroleum is one of the most obscure problems by which geologists are confronted."

I claim that these statements, that we know so little to-day about the origin of petroleum, are not warranted in the present state of geological science, and I do not hesitate to state that, on the contrary, geology can to-day most clearly prove that the origin of oil is inorganic and the result of solfataric volcanic emanations.

* This *Journal*, cliv, 143, 225, 263.

† "Volcanic Origin of Natural Gas and Petroleum," *Jour. Can. Mining Inst.*, Vol. VI

‡ "Oil Fields of the Texas-Louisiana Gulf Coastal Plain." Bulletin No. 212, U. S. Geological Survey, Washington, D. C., 1903.

It has been so long assumed that oil or bitumen is due to the decomposition of the organic remains of the sedimentary rocks, that the words organic and bituminous are used synonymously, and accordingly, without attempt at explanation, the origin of oil is in every case ascribed to some bituminous shale horizon, more or less full of organic matter. Such fallacious reasoning attributing the origin of oil to bituminous shales or to shales containing oil—that is to say to oil—of course, proves nothing except that this question is prejudged and entirely misunderstood by a great many geologists who seem to regard the abundant geological proofs that oil did not originate according to the above axiom as extraordinary phenomena and profound mysteries not yet solved by science.

Chemistry can extract hydrocarbons from organic remains and can also produce hydrocarbons from simple mineral reactions (as in the commercial manufacture of acetylene, for instance), but the question before us is not: What are all the numerous chemical reactions capable of producing hydrocarbons or bitumens? but only: How does nature do it? What are the geological facts in this connection? If in chemistry hydrocarbons are generally grouped and classed among the organic compounds, it is not a proof that the natural hydrocarbons have geologically an organic origin and that, in geology, organic and bituminous are synonymous terms, to be exchanged and used indifferently, one for the other. The geological evidence is, on the contrary, very clear and very strong in disproving absolutely the organic origin of bitumens or hydrocarbons found in the earth's strata (excepting some marsh gas); and further, it shows plainly that the natural geological process of to-day and of ages past in the formation of these products is a mineral or inorganic process. This geological evidence is so well known and so indisputable that a simple enumeration of it seems to us sufficient:

(1) Animal organic remains or bodies are never entombed in the rock formations and, therefore, cannot there produce oil or anything else.

(2) Vegetable organic remains in the rock formations

always decompose into carbonaceous matter, that is, peat, lignite and coal, with a small production of marsh gas, which, however, either escapes in the atmosphere or remains in the coal, and has evidently nothing whatever to do with the natural gas and oil of the gas and oil fields.

(3) Further distillation of carbonaceous matter has not taken place in nature, except in very local and very rare instances, as proved by all the lignite and coal beds of the sedimentary strata.

(4) As reviewed elsewhere,* and as many very able geologists and scientists have repeatedly observed and recorded, in the volcanic districts of the earth, not only gaseous, liquid and solid hydrocarbons or bitumens are among the most important products of the solfataric volcanic emanations, but also carbonic acid, chlorides (mostly common salt), sulphuretted hydrogen, sulphur, gypsum and hot calcareous and siliceous waters are always the other conspicuous products of these emanations, and all these associated products together stamp the solfataric volcanic phenomena with a unique and unmistakable seal.

That this volcanic phenomenon is the normal and orderly process of petroleum production is to us also a most clearly established geological fact for the following reasons, which we have discussed at length in another paper:†

(*a*) It is the only geological process of petroleum production to be witnessed in active operation to-day in nature.

(*b*) In all the oil and gas fields or petroleum deposits the gaseous products are under a strong pressure which is not artesian or hydrostatic, which increases with depth and which cannot be anything else than a volcanic pressure.

(*c*) In some of the oil and gas fields heated waters, oils and gases are met with.

(*d*) All the oil and gas fields bear imprinted, largely through the products associated with the oil and gas, the seal we have referred to above as the distinct characteristic of solfataric volcanic emanations.

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* "Volcanic Origin of Natural Gas and Petroleum," *Jour. Can. Mining Inst.*, Vol. VI.

† *Idem.*

(*e*) The oil and gas fields are located along the faulted and fissured zones of the crust of the earth parallel to the great orogenic and volcanic dislocations.

(*f*) Oil, gas and bitumens are never indigenous to the strata in which they are found; they are secondary products impregnating and cutting porous rocks of all ages, exactly as volcanic products alone could do.

(*g*) Oil and gas are stored products, in great abundance in certain localities, while neighboring localities often are entirely barren; and many of the strata among which they are found are so impervious that the source of these hydrocarbons must be the volcanic source below, which alone is abundant enough and alone possesses sufficient energy to force and accumulate such large quantities of these and associated products in so many spots through such impervious strata.

No other oil or gas fields conform to what has just been written more closely and more plainly than some of the fields under review in Mr. Hill's paper. Indeed, Mr. Hill shows that in the Texas-Louisiana Coast Prairie:

(1) The oil and gas are always found under small mounds or salt islands, which are gentle recent quaquaversal uplifts or uplifted domes. This is fully confirmed by C. W. Hayes in a recent paper * and by others.

(2) The salt water and the oils under these mounds are still, in some cases, hot.

(3) The oil and gas under these mounds do not occur in any definite stratum, but in spots of many strata and in very large quantities in these limited areas.

(4) The same may be said of the products associated with the oil or gas under these mounds, viz., sulphur, sulphuretted hydrogen, salt, gypsum, limestones and dolomites, which form, under these mounds, many irregular masses and pockets without any stratigraphical order of any kind.

(5) The above associated products are not found in the wells drilled outside of the mounds any more than the oil or

* "Contributions to Economic Geology," Bulletin No. 213, U. S. Geol. Surv., pp. 345, 347, 348.

gas, except in very small quantity, while under the mounds they often form very thick vertical masses, hundreds and thousands of feet in thickness.*

If we keep these now well established facts carefully in mind we cannot come to any other conclusion but the one adopted by Mr. Hill, that "these materials (of the mounds associated with the oil and including the oil) have originated by secondary replacement, and that they may be of post tertiary age."

But, in his explanation of these secondary replacements under the mounds, Mr. Hill certainly does not go far enough. In my opinion, his explanatory hypothesis which he offers on page 35 as a "basis for discussion" and not "as a final explanation" should be altered as follows:

The oil, sulphur, salt, natural gas and hydrogen-sulphide pockets of the Texas Coastal Plain are not indigenous to the strata in which they are found, but are the resultant products of columns of hot saline, silicious, calcareous, magnesian and sulphur water and vapors, associated with sulphur and hydrocarbon gases and vapors, which have ascended, under volcanic pressure, at points along lines of structural weakness, and have disseminated also, in more or less minute quantities, a little oil, gas, sulphur and salt through thousands of feet of shales, sand and marine littoral sediments of the Coastal Plain section.

These lines of structural weakness or fissures were partially sealed by the deposition of the latter overlapping strata now capping the oil pools, but the spasmodic recurrences of the volcancic emanations kept raising and partially replacing the sands and clays of these latter strata to form in spots along these fissures the present mounds and salt islands.

It will be observed that Mr. Hill's "hydrostatic pressure" is here changed to a volcanic pressure, and that the other important change we suggest is that the saline waters as

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* See also Capt. Lucas's paper, *Trans. Am. Inst. Min. Eng.*, Vol. XXIX, and the "Oil Fields of the Texas-Louisiana Gulf Coastal Plain," Bulletin No. 212, U. S. Geol. Surv., p. 126.

well as the hydrocarbon and sulphur gases and vapors are also of volcanic origin, instead of being derived from meteoric sources and from the strata and sediments beneath the Coast Prairie.

Before giving my reasons for the above suggestions, I wish to remark that they form a complete geological explanation of the origin of the oil and associated products of the mounds, while Mr. Hill's explanation is only partial and does not in any way solve the problem of the final origin of the oil, sulphur and salt which Mr. Hill simply admits, without explanation, to be disseminated in more or less minute quantities through the "bituminous" sediments of the Coastal Plain section. Nor does Mr. Hill's explanation account at all for the natural gas and for the sulphuretted-hydrogen gas which are two of the most important of the associated products of Mr. Hill's "oil-phenomena" of the mounds; it cannot, indeed, be admitted that the descending meteoric waters leach or gather also these gases downward through the sediments to the places of structural weakness or fissures, and then float these gases upward at a few spots along these fissures. My main reasons for the above suggested explanation of the origin of the oil phenomena of the mounds are based on the following simple facts:

(1) The oils, waters and gases under these mounds are not under an hydrostatic pressure, small or great. This is amply demonstrated by the fact that the once famous gushers of Spindle Top are already gushing no more and have now to be pumped. If the pressure there was artesian or hydrostatic they would be gushing yet, the same as at first, and, if the oil had exhausted in some of these wells, these would be gushing water out of the supposed artesian water column behind them. It is certainly now a well-known and admitted geological fact, that, in all the oil and gas fields, the rock pressure of the gas is a stored energy continually decreasing as the gas is used, so much so that the gas itself has to be pumped to-day in many fields where its pressure was too strong at first; and, surely, such a phenomenon cannot possibly have anything to do with an

artesian or hydrostatic water pressure. If not hydrostatic, then, what is it?

Messrs. Hayes and Kennedy, in their *recent report on these oil fields, say:* * "It appears highly probable that the pressure in the oil reservoir is due largely to the *expansive force of the associated gas.*" Quite so! But this is hardly sufficient, and the question remains: What is the expansive force of the gas due to? It remains unanswered and cannot be answered unless we go to its real volcanic source. This one word "volcanic" explains it all! And the invocation of this word is here a forced conclusion. We have indeed seen that there is no sign of the "tremendous hydrostatic pressure" † of Mr. Hill in the wells of Spindle Top, which have to be pumped now; yet there is no doubt Mr. Hill is right in his conclusion that the oil and associated products have originated by secondary replacements caused by circulating waters (accompanied by vapors and gases), and if these waters and gases were not pushed by an hydrostatic pressure, that is, did not come from above, then they must surely have come from below, pushed by a volcanic pressure.

(2) In full support of this I must now call your attention particularly to what Mr. Hill calls ‡ "the association of oil, sulphur, sulphuretted hydrogen gas, gypsum, dolomite and salt, constituting collectively what might be termed the oil phenomena" of the mounds. Is not that association the unmistakable seal I have referred to above as belonging to the solfataric volcanic phenomena? And how could that unique stamp be found under these mounds unless they had been percolated by precisely the same hot waters, vapors and gases which are emitted in great abundance, and at times with disastrous violence and pressure, along the lines of structural weakness or fissures of the volcanic districts of the earth?

Therefore, along lines of faults or of structural weakness of the Texas-Louisiana Gulf Coastal Plain, volcanic gas-

* "Oil Fields of the Texas-Louisiana Gulf Coastal Plain," U. S. Geol. Survey, Bulletin No. 212, p. 135; also Bulletin No. 213, p. 350.

† In Mr. Hill's paper under discussion, p. 40.

‡ Mr. Hill's paper, p. 34.

aqueous emanations have issued in spots, like volcanoes do along volcanic ranges, constituting at each spot "an elevating force acting vertically and lifting a small portion of the earth's crust," as Mr. Hayes * puts it, but without explaining what the force was. This force, as Mr. Hayes also recognizes, "was active down to a very recent date;" in fact, it may be said to be active now, as in places the waters and oils are hot yet and the gases are still issuing. Thus the mounds and salt-islands of that region were formed exactly as sulfiones, salses and mud volcanoes form to-day similar deposits in many typical volcanic districts of the earth, such, for instance, as in Italy † and in Java,‡ "where clouds of steam also issue from the vents and the heat is intense," and where sulphur, gypsum and salt are also abundantly associated. The only difference is one of intensity, which is less pronounced in the Texas-Louisiana region more remote from the centers of volcanic activity. An intermediate case between the mounds and salt islands of Texas-Louisiana and the Java mud volcanoes is the Trinidad Pitch Lake, which the able and most careful researches of Clifford Richardson || have determined to be unquestionably "the crater of an old mud volcano or geyser" with an influx of soft pitch at the center of the lake, amounting yet to thousands of tons yearly.

There is one more point in Mr. Hill's paper which I consider important to discuss in this connection of the origin of oil. Throughout the paper Mr. Hill divides the Texas oil deposits into two classes: the sheet-oil deposits and the pocket-oil deposits. In the first class he conceives the oil to be indigenous or nearly so, and to come from "bituminous" shales in close proximity to the sands. The bitumen (or oil) in the shales Mr. Hill admits and believes is due to the decomposition of organic matter.§ But even if that

* C. W. Hayes, Bulletin No. 213, U. S. Geol. Survey, p. 347.

† "Volcanic Origin of Natural Gas and Petroleum," *Jour. Can. Min. Inst*, Vol. VI, p. 14.

‡ *Scientific American*, October 10, 1903.

|| "The Nature and Origin of Asphalt," Long Island City, N. Y., 1898.

§ Mr. Hill's paper under discussion.

were so (which of course we only admit now for the sake of argument), Mr. Hill does not explain how the oil was able to travel out of the impervious pores of the shales into the sands. No matter how close the proximity, we think that such a movement of the oil out of the shales would be impossible, as the characteristic condition of shales is to be absolutely impervious. Even under great pressure, as there is abundant evidence in the oil and gas fields, a few feet or even a few inches of shales prevent all leakages, so much so that shales are generally considered as forming, and often do form, the impervious covers or cap rocks of the sand reservoirs, and covers or cap rocks sealing tightly and hermetically the oil from below, cannot also logically be regarded as the source from which other sand reservoirs above have been filled.

In regard to the second-class or pocket-oil deposits, the foreign or adventitious nature of the oil and associated products is so glaring that for these Mr. Hill gives up the old idea of an indigenous oil made by decomposition of organic matter; but evidently this old idea is not going to be given up without a struggle, as it is retained for all the other deposits of Texas except for the ones of the Post-Eocene under the mounds, and even these are made to originate eventually from the same organic source, but in a less direct way through the intervention of circulating meteoric waters.

The only attempt Mr. Hill makes to prove this indigenous organic origin of the so-called sheet-oil is in these words:* "Of the 22,000 feet of sedimentaries in the Texas section, all but 2,000 feet are unconsolidated clays and sands, which *may be* more or less *bituminous*. . . . Some of the lime-stones *are* also *bituminous*. . . . Oil or bitumen *has been found* in at least a dozen horizons of the section . . . In two instances in Texas *bituminous matter* (asphaltum) *is found* in apparently indigenous beds of lime-shell conglomerate. . . . The oil of the Corsicana field and that of San Antonio *is derived* from the shales of the Upper Cretaceous. . . . The strata on the Eocene Tertiary present every

* Mr. Hill's paper under discussion, p. 38.

favorable condition for the generation of petroleum, whether this material be derived from the decomposition of marine organisms, *as alleged by some*, or from the hydrocarbons generated by vegetable matter, *as believed by others. There are vast accumulations of both materials in Eastern Texas.* . . . Between the Eocene or Claiborne stratum of Nacogdoches and the uppermost Pleistocene stratum of Beaumont, there are thousands of feet of gypsiferous clays and sands in which nature *may now be distilling oil.*"

As will readily be seen, all the above proofs of Mr. Hill are simply assertions that bitumen or oil exists there (and, of course, that proves nothing as to its origin) or are suppositions against the known facts, viz., "that the oil is derived from the decomposition of marine organisms or of vegetable matter, of which there are vast accumulations in Eastern Texas, or is distilled from gypsiferous clays and sands." Is it not, indeed, known without the shadow of a doubt?

(1) That no bodies of marine organisms are or were ever entombed in these sedimentaries; shells or bones of millions of organisms were, but not one body. Just as it is in the sedimentaries being formed to-day along thousands of miles of coast lines, from which not one geologist has ever produced one entombed single body of marine or any other organism. So much for the "vast accumulations of marine organisms in Eastern Texas."

(2) Is it not also an undisputed recognized geological fact that the vegetable matter entombed in these sedimentaries (including the gypsiferous clays and sands) is to be found, and is found to-day as carbonaceous "undistilled" matter, containing yet the bitumens or oils which it would have produced had the temperature necessary for distillation ever been attained? Either there was distillation of these sediments or there was not, and the lignites, coals and other carbonaceous matter found abundantly in them to-day are most convincing proofs that there is not, and was not, sufficient heat there to cause distillation and to thus produce petroleum.

These simple geological considerations, then, lead us to

the safe conclusion that the so-called sheet-oil is not an indigenous product of decomposition of organic matter. That it is also, like the so-called pocket-oil, a secondary product of impregnation and replacement becomes quite clear when we remember that these so-called sheet-oil deposits are found not only in a dozen horizons, but in hundreds, from the oldest Paleozoic to the alluvial gravels and sands of to-day; and that nowhere do they spread like sheets; but that, on the contrary, they are always found in relatively very small pools in porous reservoir rocks, which are barren of oil outside of the little pools (exactly as in the case of the mounds), these pools forming only a very small percentage of the area of the numerous rock-sheets in which they are only occasionally found. That these accidental pools are only receptacles or reservoirs is admitted to-day by all who have studied the question. That these reservoirs were filled also from the great volcanic tank below, in a manner exactly similar to the case of the Texas mounds, is plain when all the evidence enumerated above, which geology can bring forward to-day, is considered together.

The above views on the origin of the oil phenomena, not only of the mounds and salt islands of the Texas-Louisiana district, but of all other oil deposits, lead one to a simple interpretation of the geological occurrence of oil which should be a guide to important results in the practical development of new oil and gas fields in the United States, as they have already been such a valuable guide to us in the developments of large new gas fields in Canada.* These views lead, indeed, to the following important conclusions:

*Oil and gas were only supplied along some of the lines of structural weakness, or along some of the fractured zones of the crust of the earth, and therefore the new fields are to be found only along these zones or belts.*

The numerous oil and gas fields known to-day indicate plainly quite a number of these oil belts, but more remain yet to be discovered, and new ones are coming rapidly to the front, especially in the United States. That this is the

* "Natural Gas in Ontario," *Jour. Can. Min. Inst.*, Vol. III.

solution of the problem of the geological occurrence of oil and of oil developments and explorations, the writer has long been convinced on the considerations and for the reasons given above. Our suggestions are therefore that, as far as practical results are concerned, the important point is to accurately trace these fissured zones or belts on good maps and to drill in the localities thus indicated.

I have been at work for years, ever since 1888, on maps of this character embracing North America, and I hope to be able to publish these before very long, and as soon as our present knowledge of these most important structural dislocations is a little more complete.

TORONTO, ONTARIO, CANADA,
December 5, 1903.

## AN OPEN-HEARTH FURNACE MAKING STEEL BY A CONTINUOUS PROCESS.

In a recent number of *Stahl und Eisen*, Dr. Surzycki describes an open-hearth furnace that has been working satisfactorily since September, 1902, at the works of B. Hantke, at Czenstocha. In this furnace, which is of 30-ton capacity, two tap-holes situated one over the other, but not in line, lead into a double spout by which the whole or any part of the contents of the furnace are easily tapped at any time. The furnace is charged with cold scrap to which, when melted, molten pig iron from a blast furnace or a mixer is poured in. When the bath is quiet, iron ore and mill-scale are added, and a further amount of pig iron. The charging lasts until the furnace is quite filled. The charge is de-phosphorized by adding lime, and when de-carbonization has gone far enough the furnace is tapped. The de-oxidation of the steel is carried out by adding wood carbon and ferro-manganese in a ladle during the tapping of the charge. After tapping, the upper tap-hole of the furnace is closed and the furnace repaired. A calculated amount of ore and roll-scale and a proportionate amount of pig iron is then run in. The practice is carried out uninterruptedly for one to two weeks. If, from any cause, the remainder of the furnace contents must be cast, it is easily done by opening the lower tap-hole. The method, while based on the Talbot process, has the advantage that it may be worked in an ordinary fixed furnace, if not too small.

## RAILWAYS OF THE WORLD IN 1902.

At the end of 1902 the railway mileage of the world was 352,500 miles, of which the United States had 202,471 miles, or 38 per cent., and Europe had 180,708 miles, or 34 per cent. The British Empire had 91,485 miles, or 17 per cent. of the total; the German Empire had 32,753 miles, and the Russian Empire, 31,945 miles. The United States had, therefore, six times as much mileage as either the Russian Empire or the German Empire.

# CHEMICAL SECTION.

*Stated Meeting, held Thursday, March 17, 1904.*

## Hydrogen Sulphide, Its Uses and Dangers.

By E. Goldsmith,
Member of the Institute.

It always seemed to me a far-fetched idea that "Pythia," the oracle of Delphi, who, while in the state of ecstatic frenzy, uttered words and shrieks which were assumed to be the answers of the invisible Apollo, was thrown into this state by inhaling a peculiar vapor ascending from the earth, within the *aditon* (ἄδυτον). It interests us here simply for the reason that the purely fanciful assumption has been made that the vapors that issued from the *aditon* were those of hydrogen sulphide.

That this gas is one of those bodies which excites the senses strongly no one can contradict or will dispute. The ancient authors, however, did not give us a clear and sufficient description of the gaseous matter which their oracle inhaled; because our science, "Chemistry," had not dawned upon the ancient people of Greece. That this strongly odoriferous gas was not described by the ancient authors is somewhat surprising, inasmuch as it is so frequently met with issuing from springs and craters on the northern shore of the Mediterranean Sea.

In the United States many so-called sulphur springs, as they are usually termed, occur, as, for instance, at Niagara Falls, the Yellowstone National Park, Wyoming, the Stinkwater River; and many other localities are known, where hydrogen sulphide is exhaled to the disgust of those who live in the neighborhood.

Now, in spite of the fact that the preparation called "milk of sulphur" was known in commerce at a very early date in the Middle Ages, the peculiar and malodorous gas, $H_2S$, which is regularly evolved in the process of precipitating sulphur from a polysulphuret by an acid, was not recognized prior to the eighteenth century.

The first investigators were von Meyer and Rouell; later on, Scheele and Berthollet determined the properties and the composition of hydrogen sulphide.

It is not surprising that chemists endeavored to explain the occurrence in nature of this singular compound mineral; and a number of hypotheses have been suggested. The one, that organic matter reacts on sulphates seems to be generally adopted, since this reaction has been observed in rivers and at the mouths of rivers, as, for instance, on the west coast of Africa, where the waters of the Congo and other streams laden with organic matter, when they mingle, are said to mix with the sulphates in the ocean, are said to exhale hydrogen sulphide, the reduction being stimulated by the heat of the sun.

That hydrogen sulphide is liberated by the decomposition of organic matter is universally known; that meats, eggs, fish, and certain vegetable matters which find their way into the sewers of cities play their part in contaminating the air we breathe, has been so often discussed, that I think it is not necessary to dwell upon it here; I only wish to call attention to the fact that the hypothesis above referred to seems to be plausible.

Quite remarkable is the presence of hydrogen sulphide in the boric-acid fumaroles in Tuscany, where Saint Claire-Deville and Lebbancs (*Comp. Rend.*, t. xlvii, p. 317) found this gas in quantities from 1·62 per cent. to 4·1 per cent., an amount which must be considered extraordinarily high.

Coming now to the artificial production of hydrogen sulphide, it is noteworthy that hydrogen and sulphur do not directly combine with each other, even if sulphur be heated in an atmosphere of hydrogen; but, according to Scheele and Humphry Davy, if hydrogen be allowed to pass through melted sulphur for a considerable time some hydrogen sulphide is formed. It is well known to chemists that the gas under consideration is readily formed by the interaction of many metallic sulphides and diluted mineral acids; in the nascent state, both elements—hydrogen and sulphur—easily "interpenetrate" to form the compound gas.

To describe the various forms of apparatus devised for

the production of hydrogen sulphide on the small or large scale will be unnecessary, as descriptions and illustrations of them may be found in almost all text-books on applied chemistry. One point may be of interest to state, since it is not generally known, namely, that the hydrogen sulphide is sometimes stored in large gas-holders—like the great structures erected for illuminating gas—over salt water, of course—for technical purposes on the large scale.

In all cases, however, the gas produced requires to be washed before it is brought in contact with any other substances, to avoid contamination with impurities—a matter of importance in analytical work.

The usual material from which the gas is obtained is sulphuret of iron; but sulphuret of manganese or the trisulphuret of antimony, or, better still, sulphuret of calcium or barium, may be substituted for the iron salt, etc.

Calcium or barium sulphides furnish hydrogen sulphide of a high degree of purity; and it is to be recommended that calcium or barium sulphides be used, wherever the purest kind of $H_2S$ becomes a necessity, as, for instance, in forensic investigations of poisoning cases.

Professor Reintsch observed that, if suet and sulphur are melted together in a retort, a pure hydrogen sulphide is obtained.

Hydrogen sulphide, at ordinary temperatures, is a colorless gas, having an extremely unpleasant odor, similar to that of rotten eggs. Its specific gravity is 1·1912 (air = 1). The gas is soluble in water to the extent of from two to three volumes in one volume of water at ordinary temperatures; but in alcohol, hydrogen sulphide is held in solution to even more than four times its own volume at the same temperature. However, the alcoholic solution of the gas, in the course of time, after several months, deposits crystals of pure sulphur, indicating that a slow decomposition of the compound gas has taken place.

In the dry state the gas may be condensed to a liquid, although it requires considerable pressure and a low temperature to effect such condensation.

Near —85·5° C., liquefied hydrogen sulphide becomes crys-

talline and appears like snow, or a transparent solid mass. It was Faraday who first succeeded in astonishing the scientific world by performing this remarkable experiment.

Liquid hydrogen sulphide possesses a strong refractive power; it is lighter than water; dissolves sulphur when heated and lets it fall again upon cooling. These facts were ascertained by Nieman.

The gas, or its watery solution, is of great importance in analytical chemistry. The fact that hydrogen sulphide possesses the property of combining with sulpho-bases to form the so-called double salts, indicating thereby its acid tendency, which is also recognized by its action on certain vegetable colors, leaves no doubt, according to the dualistic hypothesis, that hydrogen sulphide is an acid.

If hydrogen sulphide is passed through a red-hot porcelain tube, it is decomposed into its constituents—sulphur and hydrogen. The same decomposition occurs when the gas is subjected to the action of the galvanic current; sulphur travels to the anode and hydrogen to the kathode. Oxygen, or substances which easily part with their oxygen, act in a similar manner; they oxidize the hydrogen to water and liberate the sulphur; or, if the supply of the oxygen is great, the sulphur may be oxidized into sulphuric acid. The turbidity, often observed in the watery solution of $H_2S$, is simply the manifestation of such a decomposition into hydrogen and sulphur caused by the oxygen of the air.

Iodic, bromic, chromic, chloric, etc., acids are readily reduced by hydrogen sulphide. If hypochloric acid or fuming nitric acid be brought in contact with hydrogen sulphide, the oxidation is so intense as to cause inflammation, and even explosions may be induced. The free elements, chlorine, bromine and iodine, also react energetically upon hydrogen sulphide to form their respective hydrogen combinations, and liberate the sulphur. This property is made use of sometimes in practice on a large scale to form hydroiodic as well as hydrobromic acid, especially when these acids are demanded in a highly concentrated state.

The atmosphere of dwelling-houses, which from some cause or other become impregnated with hydrogen sul-

phide, and which, therefore, may become detrimental to health, may be purified by either evolving chlorine, or, more simply, by placing vessels containing chloride of lime in the various rooms.

Sulphurous acid and hydrogen sulphide unite to form a body which has received the name of pentathionic acid.

The importance of hydrogen sulphide in analytical chemistry, already referred to, is so great that all attempts to displace it by another reagent have thus far failed. No one in the past was more impressed with the usefulness of this gas for chemico-analytic work than the eminent German chemist, Justus von Liebig. It was he who raised hydrogen sulphide to the dignity of a group-reagent; and so successful was he with the system he suggested that all the schools in which chemistry is taught, in Europe as well as in America, have adopted it.

As a group reagent it plays its great roll in all laboratories of the world, and wherever chemical investigations are carried on it is well-nigh indispensable.

It will not be necessary to point out the groupings of the various chemical elements which Justus von Liebig first taught us to recognize in a highly complicated mixture. The general scheme can be found in the numerous text-books published since Liebig's time, and is familiar to every tyro in the science of chemistry.

We must not omit to state that hydrogen sulphide is also employed in certain metallurgical processes on a large scale. For instance, to produce pure cadmium, for which there is a constant demand in the market, copper-nickel residues by the thousands of gallons in solution are treated with the gas in question; and it seems to be at the present time the only method by which a complete separation of the two elements can effectually be accomplished.

The odor of hydrogen sulphide is so penetrating that even the merest trace can be recognized with a fair sense of smell. Traces of the gas may be made visible by its well-known reaction on paper saturated with acetate of lead, which will darken quickly if held within an atmosphere containing this interesting invisible sulphur compound.

Other compounds, like the silver and the copper salts, may also be used for the same purpose as the lead salt.

Hydrogen sulphide is very poisonous even to plant life. A green finch died immediately in an atmosphere containing only $\frac{1}{1000}$ of its volume of $H_2S$; $\frac{1}{800}$ part in air killed a medium-sized dog; $\frac{1}{200}$ part of $H_2S$ in air suffocated and killed a horse. These toxic properties on animal life are, I think, sufficient to show the strong effect it has in what we may call comparatively small quantities. That plants are also strongly affected by the presence of the hydrogen sulphide in the air, and die, has also been observed.

To those who are employed in chemical works hydrogen sulphide occasionally plays the part of a subtle and dangerous foe. Many years ago in the factory where carbon disulphide was manufactured on a large scale, the workmen, as well as those who had to use the product, were subject to a variety of physical disorders. It was believed at first that the carbon disulphide caused the troubles. The principal symptoms were general weakness, loss of appetite, and especially a serious affection of the eyes, which exhibited itself, when the subject had been long enough exposed, in a blurring of vision and temporary blindness.

About twenty-five years ago, I was consulted with the view of ascertaining the cause of these troubles and of the nastiness, as it was called, of carbon disulphide and of finding, if possible, a means of removing it. In the analytical treatment of the sample of carbon disulphide, I found that it was a mixture of two sulphur compounds—carbon disulphide and hydrogen sulphide. After separating the latter gas from the liquid and thorough washing with water, the carbon disulphide lost its nasty odor; in fact, the odor of the fluid compound now was rather a pleasant, ethereal one. The cause of the odor of rotten eggs being removed, the true odor of the carbon disulphide appeared. Since that time complaints against this substance have ceased; that is to say, if the toxic and obnoxious hydrogen sulphide gas is removed from the carbon disulphide the health of the users of the article is no longer affected.

The manufacture of carbon disulphide is now controlled

by a single maker, and he should be compelled by law not to distribute a product contaminated with hydrogen sulphide. He was taught the process of purification through my efforts, and being, therefore, familiar with it, should conscientiously practice it to avoid the poisoning of the artisans who have to handle it.

Now, another question arose, How does the hydrogen sulphide get into the carbon disulphide? Since the hydrogen sulphide causes a loss of sulphur, it is self-evident that its formation should be prevented.

I found the cause in the fact that the sulphur is exposed to the influences of the weather. The raw sulphur is usually kept in the open air and rain, snow; dust, which also carries moisture, mingles with it.

The moisture in those days was not removed from the sulphur prior to feeding it into the cylindrical apparatus in which the combination is effected with the red-hot carbon. The moisture is, therefore, the cause of the formation of hydrogen sulphide. It is a well-known fact that the vapor of water is decomposed at a red heat to form hydrogen and carbon monoxide. The hydrogen being liberated and in the nascent state, meets the sulphur and by interpenetration forms the gas hydrogen sulphide. The reaction may be illustrated by the following equation:

$$2C + 3S + H_2O = CS_2 + CO + H_2S$$

It is, therefore, of importance that the sulphur should be dried before it enters the red-hot cylinder or the electric furnace wherein the formation of the two solids takes place to form carbon disulphide.

All the carbon disulphide placed on the market should be purified from hydrogen sulphide, and no other should be allowed to reach the consumer.

But how shall the workmen be protected in works where large volumes of hydrogen sulphide are evolved either as a reagent or as a secondary product? The answer is: that the operation must be conducted in a chamber connected with a high chimney. The workmen, however, disregard frequently the order given them not to put their heads

within the gas-chamber, and the consequence is that they become temporarily blind for two or three days, or longer, suffering intense pain, with reddening of the conjunctiva; almost continual running of tears, headache, and general indisposition. Under my direct observation came three men who were affected in the manner described, and there is not the slightest doubt that the hydrogen sulphide was the cause of the trouble.

When I observed the pupils of the affected eyes they appeared gray, more or less opaque; indicating, apparently, that the hydrogen sulphide must have formed with the outer cuticle a compound which prevented the light from passing into the eyes. The patients could not distinguish objects held before them; they could not find their way home alone, and, as may be imagined, feared to lose their eyesight entirely; which, however, always returned to them, and to all of them, after the lapse of several days.

This, in my estimation, extraordinary fact, which belongs rather to physiological chemistry, has been observed by the writer repeatedly on a number of workmen.

They, as a rule, went to the hospital for treatment. The diagnosis must have been a puzzle to the physician in charge, inasmuch as the workman could never explain the cause of the trouble. Therefore, this short story told of hydrogen sulphide may be considered as a small contribution to physiological chemistry for the benefit of those especially who have to diagnose and treat affections of the eyes.

Many working people at present are exposed to dangers from noxious gases in the various industries, and it seems to me, in this connection, that the effects of these gases, especially upon the eyes of men and domestic animals, are not sufficiently considered and emphasized. Whenever observations like the above are made the facts should be published in the interests of humanity.

PHILADELPHIA, March 17, 1904.

# Notes and Comments.

## ARTIFICIAL RUBIES.

In 1887, M. Frémy, with the aid of his *preparateur*, M. Verneuil, undertook new experiments on the crystallization of alumina, and had the satisfaction of obtaining very beautiful artificial rubies. The method employed consisted in causing the reaction at a red heat of barium fluoride on alumina containing traces of potassium bichromate. The new crystals, instead of being formed in a hard, vitreous, lamellar gangue, like that obtained in 1877, now appeared in a porous and friable gangue, regularly crystallized and of absolute purity. The samples presented to the Academy of Sciences were recognized, after examination, as formed of pure alumina, only colored with traces of chrome, and in all points to be compared with natural rubies. Their crystallization is rhomboidal, their brilliancy really adamantine, their shade exact and their transparency perfect. They have the hardness of the natural ruby; and, like it, become black when heated, resuming their beautiful rose tint on cooling.

Now M. Verneuil, to-day professor at the Museum, has discovered the method of producing the ruby artificially by melting a mixture of alumina and oxide of chrome at a constant temperature of several thousands of degrees, and in layers superposed from the outside to the inside, in order to prevent the production of cracks in the crystalline mass. This eminent chemist has succeeded in creating a magnificent ruby, weighing about 2,500 grams, and having a commercial value of about 3,000 francs.

For securing the extreme temperature indispensable for the success of this operation, M. Verneuil had recourse to a vertical oxyhydrogen blowpipe, the flame of which was directed from above downward. The hardness of the stone was secured by an energetic tempering, suddenly suspending the action of the blowpipe.

The ruby of M. Verneuil has admirable fluorescence, on account of its great purity. It possesses all the physical properties of the natural ruby, and, like the natural ruby, can be cut and receive a very beautiful polish.

We hope that now the desire expressed by MM. Frémy and Fiel in 1877 will be realized, that industry will draw advantage from this splendid discovery, and that the jewelers and the general public will share the advantages. A manufactured ruby is not to be considered as a spurious ruby when it possesses all the crystallographic, physical and chemical properties of the natural ruby. We see no reason why any difference between them should be established. Further, and from the very fact that such a stone is the marvelous result of the incessant efforts of experimental science, it should have for us as much value, if not more, than the natural ruby.

## SHIP CANAL TO CONNECT THE BALTIC AND BLACK SEAS.

It is stated that an American syndicate has proposed to the Russian government to construct a canal from the Baltic to the Black Sea for the sum of

$160,000,000, which is one-third less than the estimated official cost. The junction of its great northern and southern seas by a navigable estuary of sufficient width and depth to permit of the passage of men-of-war and ships of great tonnage has long been a favorite project in the councils of the Czar. At the present stage of the undertaking there are two, and only two, plans of procedure. One is to utilize the existing Beresina Canal by widening, deepening and generally extending it; and the other, to adopt a perfectly new route altogether. According to the *Uhland Verkehrszeitung*, the plans of the canal have been recently deposited with the Minister of Ways and Communications, in which the proposed new route has been minutely and fully defined. The canal will commence at Riga, which, next to St. Petersburg, is the most important of the Baltic ports of Russia. It will avail itself, wherever practicable, of such portions of rivers, canals and other waterways it may meet with in its course as can be made to profitably contribute to the success of the whole undertaking. For 125 miles it will absorb a part of the channel of the Divinea, as far as the fortified town of Dunaburg. Thence it will run through a deep straight cutting 100 miles long, and join up with the river Beresina at Lepel. From this point it will follow the canalized river to its junction with the Dneiper, and use the latter stream for the rest of its course to the Black Sea at Kherson, to the west of the Crimea, near Odessa. From the one sea to the other the distance will not be less than 1,000 miles by the new scheme of inland navigation. The cost of construction, according to the offer made, would amount to $160,000 per mile, which is not an unreasonable price to pay. In addition to the value of the canal as a considerably cheaper route for the transport of goods, it would in war times possess a strategic importance probably exceeding that belonging to the "Kaiser Wilhelm" waterway. It is calculated that Russian armorclads could thus navigate the kingdom from sea to sea in half a dozen days.—*Scientific American.*



## Book Notices.

*The Metric Fallacy*, by Frederick A. Halsey, and *The Metric Failure in the Textile Industry*, by Samuel S. Dale. New York: Van Nostrand & Co. 1904.

This book is an outgrowth of a paper presented to the American Society of Mechanical Engineers, December, 1902. The first named author is associate editor of the *American Machinist* since 1895, though the style of both parts of the book would seem inconsistent with even limited editorial experience, or the possession of the most modest ability for dispassionate discussion, the writer of the preface hurls himself against the two hundred million people more or less who have been heretofore contentedly conducting their affairs by the metric system, and ignorant of the losses they were thereby incurring, and the ludicrous position they were occupying in the opinion of the authors of this book. At the outset we learn that the whole world had failed to comprehend the "limited use of the metric system," because no proof to the contrary had been offered, until Messrs. Halsey and Dale produced it. The advocates of the metric system have, with malicious duplicity, conveniently

assumed, "when any Government passed a law favorable to the system," that the law was enforced. These editors are sorry for the millions turned into ridicule by this 231 page octavo, but the sufferers have only themselves to blame. Do these ill-informed metricians imagine there has been an extensive literature on the subject? On the contrary, this book is "the only considerable collection of facts relating to the use of the system that has ever been published." Think of that! Since its adoption after all European countries had been invited to a conference to secure uniformity of weights and measures, which France, the Netherlands, Denmark, Sweden, Spain, Switzerland, Sardinia, Rome, and the Cis-Alpine and Ligurian Republics actually attended; after Borda, Lagrange, Laplace, Monge, Condorcet, had exhaustively considered the respective advantages of Huyghens' pendulum and Picard's arc of the earth's circumference, and decided in favor of the latter; after Thomas Jefferson, John Quincy Adams, Bache, Hilgard, and a host of Committees of Societies, Parliaments and Congresses have turned the question inside out for one hundred years, it has remained for Messrs. Halsey and Dale to give to the world "the only considerable collection of facts"!! The first sentence of the introduction is an illustration of the kind of facts these gentlemen are capable of giving. "The English system of weights and measures *is the exclusive standard of all English-speaking countries*, the metric system is the exclusive standard of no nation on earth." (Italics ours.) The sufficient reply to this is that in Great Britain and her Colonies the metric system has been legalized since 1864, and in the United States since 1866, consequently it is the grossest of errors to assert that the English system is the exclusive standard. If it be answered that the English standards are used in fact, though others may be recognized as legal, the rejoinder is that long before 1860 a large number of the workers of both Great Britain and the United States, namely, those in science, used and have ever since used the metric system exclusively. Moreover, a very large and increasing number of pharmacists, tailors, cabinet and instrument makers and others have used the metric system from early in the last century to the present time. In view of these facts what excuse can the authors of this book offer for the reckless statement above quoted? This is a specimen of the book's accuracy.

As an example of its fairness we see on page 13 a sub-heading "Pro-metric Argument." On reading the two and a quarter pages which profess to give this argument we find only quoted opinions of various persons that the changes could be effected in a short time (most frequently two years). All the powerful array of calculations and statistics of a century are ignored. On the following page and a quarter, entitled "The Anti-metric Argument," one finds difficulty, persistence of old units; destruction of mechanical standards; uselessness for foreign trade; the bill before Congress is a compulsory measure (most governmental laws are); the metric system has no superiority, and no time is saved by employing it; the confusion in the English weights and measures is a fiction; that our units are the best in the world.

It is useless to pursue seriously the unreasoning denunciations of a book published in this spirit. The negative of the question is insisted upon with an absence of supporting facts and with a vehemence characteristic of a school debating club. A great deal of space is devoted to proving that non-metric

units are used in countries where the metric is the established system. To a limited degree this is true. Diamonds are sold both by the carat and by the grain; the circle is divided into 360° both in France and Germany; but the inference which is drawn from the parade of names of measures not metric on pages 60 to 69, is amusing to those who are familiar with the customs in some of the countries mentioned. It looks as if the author of this list had collected together all the archaic names for measures of quantity which have ever been used, and made of them an alphabetical arrangement, putting opposite to each name of a measure the country where it once was used. Probably not five per cent. of the measures given are now used as intimated; but if, instead of this, all were used, they would not together make as large a percentage of foreign matter in the infinitely expansible metric system as the words of foreign origin in the text of the book before us; yet its authors would not admit that their English was a failure. The attempt in the second part to show that the metric system is not adapted to the textile industries is thrown away. The metric system binding together line, area, capacity, and weight, provides new units at any of the multiples or subdivisions of its scale, which latter are spread out evenly from the smallest to the greatest, instead of being crowded together at uneven intervals, as are the English units. By the simplest of laws all these divisions are commensurable without other than definite decimal fractions. If need be, the scale or net or cube may be based on a unit which is the thousandth, or the millionth for that matter, of the millimeter if an atom or a light wave is to be measured. This same scale will furnish units for expressing the distances of the stars by mere multiplication by the powers of ten. To pretend that such a system is incapable of meeting the wants of yarn manufacturers is absurd.

The authors have a perfect right to object to a change of their standards and to familiarizing themselves with a system to which they have not been accustomed. This is only natural and human, and, in fact, is a necessary consequence of any attempt at improvement or reform; but if they have not the time or the inclination to possess themselves of the literature and the facts connected with the movement; and if they are unable to discuss the question calmly with scientific accuracy they should not publish a book on the subject. F.

# Franklin Institute.

[*Proceedings of the stated meeting held Wednesday, May 18, 1904.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, May 18, 1904.

PRESIDENT JOHN BIRKINBINE in the chair.

Present, 45 members.

Additions to membership since last report, 11.

The resignation of Dr. Henry Leffmann from the Committee on Science and the Arts is reported, and Dr. W. J. Williams is duly elected to fill the vacancy.

Mr. Horace Pettit, sometime Solicitor of the Institute, presented and commented upon the decision of President Judge Willson, of the Court of Common Pleas, No. 4, in the amicable suit instituted by the Institute against the Trustees of the Elliot Cresson Medal Fund to determine several questions of difference, but chiefly whether the Trustees are empowered under the deed of trust of Elliott Cresson, to exercise the right of passing judgment as to the propriety of the awards of the medal made by the Institute.

Mr. Pettit reported that the Honorable Court had decided the case in favor of the Institute on all points. The gist of the decision is that:

> "So long as it (the Institute) acts in such a manner (*i. e.*, in good faith) we are of the opinion that the Institute must be regarded as having the right and the sole right to determine how and to whom the medals shall be awarded."

Prof. Edgar Marburg then gave an informal account of the organization and methods and aims of the American Association for Testing Materials.

(Mr. H. R. Heyl in the chair.) Prof. A. E. Outerbridge followed with some remarks upon the "Dangers Arising from the Use of Cast Iron in the Construction of Steel Skeleton Structures." The speaker, after alluding to his recent communication to the Mechanical and Engineering Section describing his observations on the permanent deformation (expansion) of cast iron by repeated heating and cooling (see the *Journal*, CLVII, 121; February, 1904), referred to the recent great fire in Baltimore, where numerous buildings in which cast iron had been used for door and window frames and other portions of interior construction, suffered practically complete destruction of their interiors from the distortion of this material; and that where cast iron had been used for the fronts of buildings, or their principal supports, they had suffered, in most cases, complete destruction. Emphasizing the radical difference in the behavior of steel (which is not permanently deformed on heating), the speaker called attention to the fact that in numerous cases, in Baltimore, where the interiors of steel skeleton buildings had been completely destroyed, the steel frame work had remained intact and in perfect alignment, having suffered no substantial injury.

Mr. W. N. Jennings exhibited and commented on a series of lantern photographs of views made during a recent professional trip in Cuba.

The thanks of the meeting were tendered to the speakers of the evening.

Adjourned.

WM. H. WAHL,
*Secretary.*

## Committee on Science and the Arts.

(*Abstract of the proceedings of the stated meeting, held Wednesday, April 6, 1904.*)

PROF. LEWIS M. HAUPT in the chair.

Present, 30 members.

The Secretary reported the election of Messrs. A. W. Allen, Richard L. Binder and Wm. H. Thorne as members of the Committee in place, respect-

ively, of Prof. Edgar Marburg and Clayton W. Pike, resigned, and Luther L. Cheney, deceased.

The following reports were acted on:

(No. 2246.) *Enclosed Arc Lamp.*—J. Allen Heany, Philadelphia.

ABSTRACT.—The invention is covered by United States letters-patent, No. 678,952, July 23, 1901, and No. 693,706, February 18, 1902, granted to applicant. The first of these relates especially to combined electro-magnet core and clutch for regulating the feed of the upper or movable carbon; the second has special reference to the application of a movable solenoid coil for readily changing the amperage of the lamp without changing the regulating resistance, and a dash-pot connected with the core clutch to prevent sudden movements or "chattering" of the upper carbon.

These features of construction require illustrations to be made comprehensible.

The report recognizes that the Heany lamp, in respect of mechanical construction, is exceedingly compact and light; also that it appears to be durable. The special features of construction covered by the patents above named are recognized as highly meritorious.

In tests of the lamp conducted under the supervision of the sub-committee, two of the Heany lamps (110 volts, 5 amperes) gave an average of 127 hours continuous burning with $\frac{7}{16}$-inch carbons. A third lamp with ½-inch carbons ran for 162 hours—a performance which the sub-committee regards as "commercially" satisfactory. Furthermore, a lamp was short-circuited for one hour, with a current averaging 15 amperes, and, though the resistance wire and solenoid were heated cherry-red, and the adjacent parts were tarnished, the lamp suffered no permanent injury.

The award of the John Scott Legacy Premium and Medal is recommended to the inventor. (*Sub-Committee:* L. G. Rondinella, Chairman; T. Carpenter Smith, Charles C. Heyl, Kern Dodge.)

(No. 2279.) *Electric "Buzz" Fan.*—S. S. Wheeler, New York.

Referred to Sub-Committee for further consideration.

The following reports passed first reading:

(No. 2314.) *Metallic Fireproof Window.*—D. Lupton's Sons Company, Philadelphia.

(No. 2315.) *System for Storage of Coal, etc.*—James M. Dodge, Philadelphia.

(No. 2317.) *Paral'ax Stereogram.*—F. E. Ives, New York.

(No. 2319.) *Computing Machine.*—Charles W. Draper, Washington, D. C.

W.

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WEDNESDAY, MAY 4TH, 8 P.M. Mr. Chas. E. Ronaldson in the chair. Present, 17 members.

The following reports were acted on:

(No. 2314.) *Metallic Fireproof Window.*—David Lupton's Sons Company, Philadelphia.

The subject of this report is a fire-resisting window constructed entirely of sheet metal and glazed with wired glass. The fire-resisting qualities of wired glass are now fully established and recognized by the underwriters, and this

material has made possible the construction of a window that will resist the passage of fire without being enclosed in metal shutters. The construction is such that it will close automatically under the influence of heat, a fire-safety provision on which much stress is laid by the manufacturers. Also, the sashes are so inserted in the sliding-sash styles that they may be caused to revolve, simplifying the task of window cleaning and doing away with the danger incident to performing this work from the outside. The mechanical details can be made intelligible only by illustrations.

The report of the committee finds that the following claims of the makers are substantiated, viz.: That the window is sightly and substantial; that it is an efficient fire-screen; that it is practically self-closing when subjected to unusual heat; that it is convenient in operation, easily managed for cleaning and unusually air-tight when closed. The manufacturers are awarded the Edward Longstreth Medal of Merit. *Sub-Committee:* H. R. Heyl, Chairman; Chas. A. Hexamer, Wm. McDevitt.)

(No. 2315.) *System of Storing Coal.*—James M. Dodge, Philadelphia.

This improved system and apparatus for storing and handling coal and analogous materials is protected by numerous letters-patent granted to applicant. The object sought to be accomplished is to handle large quantities of these materials, rapidly and with the minimum percentage of loss. The two chief functions embodied in the system are: (1) The stocking or trimming-out of coal to be stored, and (2) reloading the stored coal for shipment. In addition to these principal features there have been introduced arrangements for screening the coal before reloading into cars and for drilling cars by haulage. These operations are performed by continuous conveyors for the purpose of storing anthracite coal in heaps on level ground, on hillsides, or in buildings of any shape or capacity.

A number of extensive plants are operating under this system, handling many thousands of tons daily, and others are in course of erection. While official figures of the cost of storing and reloading are not accessible, the committee has had submitted to it evidence to prove that the labor cost will not exceed 3 cents per ton.

All the essential features of this system are fully covered by United States letters-patent, twenty-eight in number; of these the report enters into detailed description of eight, referring respectively to "Chain-Cable," "Chain Drive," "Chain-Wheel," "Removing Pile of Coal," "Process of Piling Coal," "Conveyor through Bottom," "Machinery for Handling Coal," and "Apparatus for Piling Coal." There patents range in date from No. 264,139, September 12, 1882, to No. 502,555, August 1, 1893. An intelligible description of all the details of the Dodge system and apparatus being impossible without the aid of illustrations, the reader is referred to the patent specifications and drawings. The following digest of the patents above named, will suffice for an understanding of its principal features, viz.:

The Dodge system comprises a chain conveyor supported by a sheer-truss, constituting a trimming machine, employed to pile coal, etc., together with a pivoted ground conveyor involving a flighted chain mounted upon a steel frame actuated by power in all its movements, and which is employed to reload the coal, etc., cars. The sheer-truss of each machine spans the pile to be formed and is fixed at the angle of repose of coal (27°).

One reloader is commonly employed with two trimming machines, forming a group; the storage plant will then consist of a number of these groups, and these may vary in capacity.

In operating a plant where the coal is received in a hopper beneath the receiving track, it is fed through a chute to the conveyor of one of the trimming machines, which carries it to the apex of the coal pile as it is building. The bottom of this conveyor is a steel ribbon 12 inches wide, which is wound from a drum located at the foot of the truss, so arranged that it is drawn out along grooves in the conveyor trough, and so that its end, or discharge point, is always at the constantly rising apex of the pile. As the arrangement only permits the coal to drop a few inches, the loss by breakage is reduced to a minimum.

The reloading machine consists of a horizontal and an inclined portion, which work together, in order to carry coal continuously from any horizontal position to a point where a pocket is located to receive the coal; thence it is discharged into cars or vessels. The horizontal portion of the reloader is pivoted at the foot of the incline and provided with wheels, which permit it to run on circular tracks, which latter are placed between and under the two heaps constituting a group. The power mechanism is so applied, that one man upon the platform operates the reloader, taking coal from either pile as may be required.

Each trimming and reloading machine handles 3 tons per minute, 180 per hour, or 1,800 tons per (ten-hour) day, so that while one pile is being stocked with one size, another size can be reloaded simultaneously from the other pile of the group. Its handling capacity equals 3,600 tons per day. A plant is therefore estimated by the number of groups it contains. Thus a plant of five groups (ten piles) can handle 18,000 tons per day; *i. e.*, 9,000 tons received and 9,000 reloaded. The speed of the conveyor is 100 feet for piling and reloading. The cost is 3 cents per ton handled.

Modern construction of anthracite coal storage plants under the Dodge system involves the use of conical piles varying in capacity from 25,000 to 60,000 tons per pile, having a diameter at the base of 247 to 331 feet. In order to form a pile having a capacity of 25,000 of anthracite coal, the trimmer trusses must be 153 feet long from center to center of pins; while for a 60,000-ton pile the trusses will be 196 feet long; 2,400,000 tons of coal are stored by means of this system in the United States, the largest plant having a capacity of 310,000 tons.

The report concludes as follows: "It appears that the successive inventions of Mr. Dodge have resulted in the development of an entirely new and economical system of handling coal, and one that varies widely from the system formerly in vogue. We are informed that during the interval of sixteen years since this system was inaugurated not one of Mr. Dodge's patents has been infringed, and this coal storage system has come to be regarded as a standard one."

In view, therefore, of its novelty and demonstrated utility the Committee recommends the award of the Elliott Cresson Medal to James M. Dodge for his improvements in the methods of storing and reloading coal. (*Sub-Committee:* James Christie, Chairman; Chas. E. Ronaldson, John M. Hartman.)

(No. 2317.) *Parallax Stereogram.*—Fred. E. Ives, New York.

The subject of this invention, covered by United States letters-patent, No.

725,567, April 14, 1903, granted to the applicant, comprises a photographic transparency which, without the use of a stereoscope or other optical device, shows the objects photographed in perfect stereoscopic relief; apparently as solid objects beyond, or in front of, the glass transparency.

The stereogram is composed of a photographic transparency, which is a line composite of the two images of an ordinary stereoscopic photograph, and an opaque line cover, mounted over the photograph with a separation of 1 millimeter.

The stereogram negative is made by placing a line screen in front of the sensitive plate and exposing the same in a camera having two lenses, or two openings in a diaphragm behind a large lens, placed about 70 millimeters, or the pupillary distance, from center to center. This initial negative is most readily made by means of two lenses which occupy the same focal length and relative position to the line screen and the sensitized plate that the eyes of the observer are to occupy in relation to the line screen and finished transparency.

The relative position of the image to the plane of the finished stereogram may be varied by the use of pivoted inverted prisms in connection with the lens or lenses at the time of taking the initial negative.

The positive from the composite negative is mounted with a line screen similar to the one used in making the exposure, and this combination, when viewed from approximately the same distance as the focal length of the lens, is resolved into a single picture in perfect stereoscopic relief.

This stereoscopic effect is caused by the fact that the elements of the composite picture alternate with each other, and, being covered by an alternately opaque screen, each eye picks up only one set of lines; namely, that set which represents those of the stereogram intended for it, while the lines constituting the other element are hidden from the eye by the opaque lines of the covering screen.

The report concludes that parallax stereograms may prove an interesting and valuable aid in demonstrating the principle of stereoscopic vision, in schools and colleges, and may also prove to be desirable and interesting as window transparencies

In consideration of the ingenuity displayed by this device and the perfection of its operation, the award, to the inventor, of the John Scott Legacy Premium and Medal is recommended. (*Sub-Committee:* Martin I. Wilbert, Chairman; U. C. Wanner, J. W. Ridpath, Max Levy, Samuel Sartain, Chas. F. Himes.)

(No. 2319.) *Computing Machine.*—Chas. W. Draper, Washington, D. C.

This device is in principle a prepared table of the products of two series of a limited number of factors, so arranged that by operating the respective buttons the desired product will be the only one of the table of products that will be presented to view.

The details of the mechanism require for intelligible description the use of illustrations.

The report finds that the machine is a departure from other computing machines; also, that while it is limited in its individual application, it is capable of being adapted to a wide range of uses, not only for stores and market stands but also for various computations of limited range, such as

weekly pay rolls, etc. The Committee awards to the inventor the Edward Longstreth Medal of Merit for the ingenious conception and execution of this machine. (*Sub-Committee:* Hugo Bilgram, Chairman; E. Goldsmith, Geo. Hoadley, George S. Cullen.)

(No. 2324.) *Lincoln Lessons on Graphic Geography.*—McCaskey.

(An advisory report.)

The following reports passed first reading:

(No. 2320.) *Tent Fastening.*—James J. Rinn, Philadelphia.

(No. 2326.) *Feed Water Regulator.*— —— Burrows.

(No. 2328.) *Storage Structure for Coal, etc.*—James M. Dodge, Philadelphia.

(No. 2186.) Protest of the Pelton Water Wheel Company, of San Francisco, against report awarding the John Scott Legacy Premium and Medal to Wm. A. Doble, same place, for Improvements in Tangential Water Wheels.

For reasons deemed sufficient, the sub-committee charged with this investigation reported that the allegations set forth in this protest are not sustained. The Committee's recommendation was thereupon confirmed, and the protest was dismissed.

The resignation of Dr. Henry Leffmann as a member of the Committee was presented and accepted. W.

## Sections.

[*Abstracts of Proceedings of Stated Meetings.*]

MINING AND METALLURGICAL SECTION.—*Stated Meeting*, held Thursday, April 21st, 8 o'clock, P.M. Mr. G. H. Clamer in the chair. Present, 96 members and visitors.

Major Ralph W. Abercrombie, U. S. A., read the paper of the evening on "The Copper River Country of Alaska."

The speaker described in his communication the work of two exploring expeditions conducted by himself, the principal object of which was to discover and locate a route from the seaboard to the interior of Alaska through American territory—a so-called all-American route.

The first of these expeditions, which was begun in 1884, engaged in the exploration and survey of the Copper River Valley to the Yukon drainage. The result of this expedition, "while it developed the topographical features of the Copper River Delta and Port Valdez, were of a negative character so far as developing an all-American route was involved."

The second expedition was undertaken in 1898, and had for its purpose a continuation of explorations from Prince William Sound to the Yukon River. The result achieved was the working out of the topography of almost the entire Copper River Valley, and the demonstration of the existence of an "all-American" route from Prince William Sound to the Yukon Valley.

The subject was freely discussed and the paper was referred for publication.

The speaker received the thanks of the meeting.

Adjourned.

WM. H. WAHL,
*Secretary.*

## Improved Machinery, Apparatus and Processes.

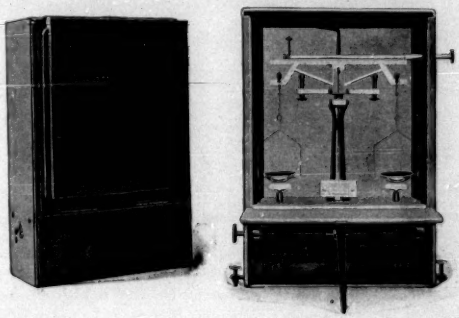
[This department will contain from month to month descriptions of new machines, apparatus and processes. The data, for which the editor must depend largely on information derived from interested sources, will be carefully edited. The Committee disclaims responsibility.—THE COMMITTEE ON PUBLICATIONS.]

### THE LILLIPUTIAN ASSAY BALANCE.

The following description, with illustration, relates to an extremely compact and serviceable portable assay balance made by Henry Troemner, 911 Market Street, Philadelphia.

The apparatus is designed to meet the requirements of the traveling assayer or prospector, and accordingly has been made so small and of such light weight that it can readily and safely be carried in the pocket.

The entire balance and case is made of a special alloy of aluminum having nearly the tensile strength of steel.



The beam is 3 inches long, oxidized black, with white divisions. It is divided both sides of the center knife edge into fifty divisions, and is supplied with rapid adjusting arrangement.

All bearings are agate. The feet have detachable screws. Levels are inlaid in the base of the case. Fall away beam and pan rests make the releasing of the beam and pans smooth and free from jerks and jars. The movements are, first, the release of the pans, and then the beam. This method is free from kicks and makes possible very rapid weighing. The rider carriage has full clear sweep across beam (there is no obstruction) and the rider can be placed at any point, from O at the center to the last division on the beam, which is directly over the end knife edge and represents the full weight of the rider used.

The case is made as follows: The base is cast from specially alloyed aluminum and is divided into three compartments. The top compart-

ment extends the full width of the case, and in it works the rod that operates the beam and pan rests, and it is also utilized to carry the adjusting feet, arrest button and shelf leg. The lower left-hand compartment is for the weights, and the lower right-hand compartment is for the pan supports and the pans. The superstructure of the case is made of the same aluminum alloy rolled hard, and is made of one piece, and is provided with mica glass (unbreakable) sashes front and back. The front sash is made to slide, like any window sash, and can be raised to any height and remains where placed. These sashes, front and back, are provided with outside grooves. There are provided two slides, one for each sash, these are slid into these grooves before the mica glass sash, when the balance can be carried anywhere with safety. The base compartment is supplied with a lid which opens up and out, and this is utilized for a shelf in front of the balance and is supported by one of the leveling legs.

There is supplied with the balance a full set of platinum weights from 1 gramme to 1-10 milligramme.

The beam is never removed from the column when not in use, and when carrying it about it is held firmly and securely in place by moving over upon it the little finger attached to the back of the column.

## AUTOMATIC CEMENT TESTING MACHINE.

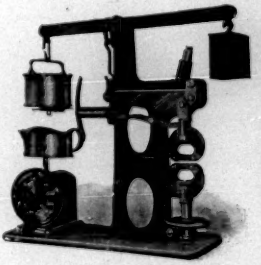
This machine was designed to supply the demand for a reliable automatic machine of this class.

Referring to the illustration, it will be seen that the machine consists, as usual, of a mechanism for applying the load on the test briquette, and means for weighing this load. The load is applied through a system of levers by means of the weight seen on the extreme right. Before starting a test, this weight is counter-balanced by shot held in the kettle on he left end of the same beam To make the test, the valve in the bottom of this kettle is opened, and as the shot escapes its equivalent of the weight on the right-hand end of the beam acts on the briquette. At the instant the briquette breaks, the escaping stream of shot is cut off by the closing of the valve in the bottom of the kettle. This is effected by the upper grip striking the horizontal arm which extends just above it, thus releasing the curved arm carried on the spindle immediately to the left, this curved arm in turn striking the valve and closing it. The briquette having broken, and the stream of shot having been cut off, it only remains to weigh the amount of shot that has escaped from the pan and multiply it by the proper factor to give the load per square inch to which the briquette has been subjected.

This shot might be weighed on any scale desired, but for facility in making tests, the machine is furnished with a spring balance, on which is placed the pan into which the shot falls. The dial of this spring bal-

ance is graduated so as to read in terms of pounds to the square inch on the specimen. It follows that as the test proceeds, the operator can watch the application of the load, and knows at any instant exactly what load is on the briquette. When the briquette breaks, the load which broke it is read at a glance, and jotted down without further manipulation or calculation. The shot is then poured back into the kettle and the machine is ready for the next test.

The small hand-wheel for adjusting the lower grip is arranged so that it will automatically slip on the adjusting screw as soon as a predetermined load has been applied to the briquette. This hand-wheel having been properly adjusted, there can be no strain on the briquette by pulling too hard on the wheel.



The principal advantages claimed for this machine are as follows:

The machine is automatic to its full capacity, and is not touched from start to finish of test; the instant the briquette breaks, the breaking load is read on the dial of the scale; the load is applied with absolute smoothness, and impact from falling shot is eliminated; the cut-off on the shot kettle is practically instantaneous; all shot that has escaped from the kettle has already done its work, and the column of falling shot in the air when the specimen breaks is, therefore, weighed as it should be; a new grip, which brings the strain uniformly on the specimen, is used; the briquette hangs clear of the frame of the machine, giving plenty of room for the hands when adjusting specimens.

The machine was designed and is built by the Falkenau-Sinclair Machine Company, 109–115 North Twenty-second Street, Philadelphia.

## RIEHLÉ VERTICAL SCREW-POWER TESTING MACHINE.

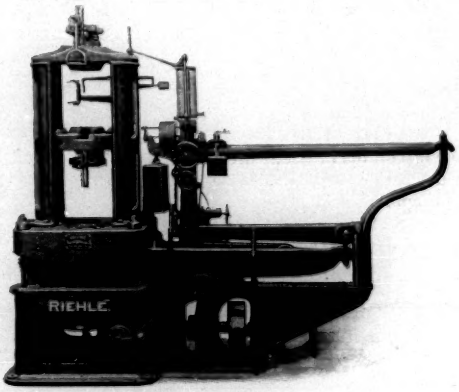
The machine illustrated by the accompanying engraving embraces the most recent improvements adapted to testing machines, by the designers and manufacturers, Riehlé Bros. Testing Machine Company, Philadelphia.

This machine is made in capacities ranging from 10 tons to 250 tons and over, and the weighing beams are adjusted to the standards of all nations.

It stands 7 feet from its base, 9 feet 3 inches long and 2 feet 9 inches wide or deep, and weighs about 6,000 pounds. It will take in tensile specimens 2 feet long or less with 33⅓ per cent. elongation in 12 inches

for 2-foot specimens, and more for shorter ones; round specimens 2-inch diameter or less; square specimens 2 inches square or less; flat specimens 3 x 1 ½ inches or less; transverse specimens 2 feet or less to 6 inches long; compression specimens 2 feet long or less. The compression surfaces are 6 inches in diameter; the motion of pulling head is 2 feet. There is a quick speed for setting the head, a slower speed for testing, and a very slow speed for making crushing tests.

The machine is self-contained; that is, no parts pass below the base line, so that it can rest on a cement or stone floor without cutting the same, and it can be placed on the second floor of a building without special foundation, provided the floor is sufficiently rigid.




It can be operated, if desired, by electric motor and a Renold's silent chain drive, an arrangement which has proved very satisfactory.

For holding flat tensile specimens of boiler plate, etc., the high-faced wedge grips made by the builders are recommended. The starting, stopping, or reversing of these machines is readily controlled by the operator by appropriate levers.

The automatic feature is unique, and the movement of poise backward and forward is guided by the action of the material being strained, whereby when the strain is increasing the poise moves out instantly and quickly, thus restoring the equilibrium and the poise rests, and again advances only when the strain is again increased.

The autographic feature is also worthy of notice, and the card is produced by the action of the specimen through the automatic feature above referred to.